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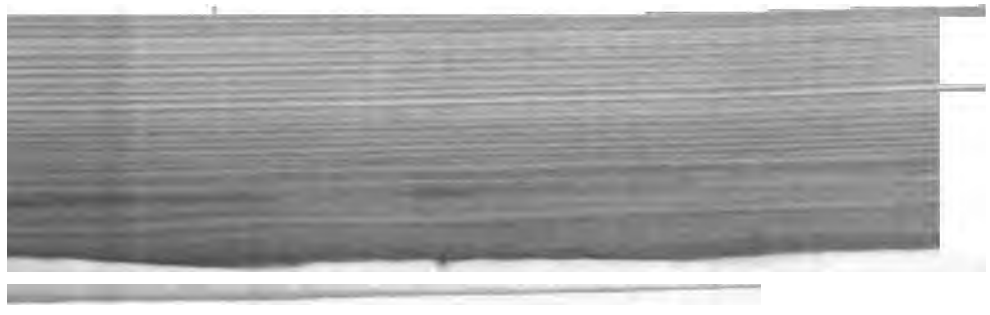

INTESTINAL ANASTOMOSIS (Sm...

# SURGERY

A PRACTICAL TREATISE
WITH SPECIAL REFERENCE TO TREATMENT

BY

C. W. MANSELL MOULLIN, M.A., M.D. OXON.

FELLOW OF THE ROYAL COLLEGE OF SURGEONS; SURGEON AND LECTURER ON PHYSIOLOGY THE LONDON HOSPITAL; FORMERLY RADCLIFFE TRAVELING FELLOW AND FELLOW OF PEMBROKE COLLEGE, OXFORD, ENGLAND

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SECOND AMERICAN EDITION

REVISED AND EDITED BY

JOHN B. HAMILTON, M.D., LL.D.

PROFESSOR OF THE PRINCIPLES OF SURGERY AND CLINICAL SURGERY, RUSH MEDICAL COLLEGE, CHICAGO; PROFESSOR OF SURGERY, CHICAGO POLYCLINIC; SURGEON, FORMERLY SUPERVISING SURGEON-GENERAL, U. S. MARINE HOSPITAL SERVICE; SURGEON TO PRESBYTERIAN HOSPITAL; CONSULTING SURGEON TO ST. JOSEPH'S HOSPITAL AND CENTRAL FREE DISPENSARY, CHICAGO; SECRETARY-GENERAL OF THE NINTH INTERNATIONAL MEDICAL CONGRESS, ETC.

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# AUTHOR'S PREFACE TO FIRST EDITION.

Modern Surgery has advanced with such rapid strides, and in so many different directions, that it is almost impossible, within the space of a single volume, to give more than an epitome of its main principles. I have heretofore touched but lightly upon controversial matters, and have endeavored to make this book a practical one, in the hope that it may be of greater service to students and general practitioners. With this object, I have given special attention to the question of Treatment; and I have included under the head of each organ a brief description of the malformations to which it is liable, and the various operations that may be performed upon it, instead of relegating them to chapters by themselves. The General Pathology of Surgical Diseases is dealt with in Part I; that of Injuries in Part II. In Part III the Diseases and Injuries of Special Structures and Organs are considered more fully. Throughout, I have endeavored to enforce the idea that the chief aim and object of Surgery at the present day is to assist the tissues in every possible way in their struggle against disease.

Through the kindness of the publishers, I have been enabled to make use of many illustrations from Bryant's "Practice of Surgery," Fergusson's "Surgery," and Astley Cooper's work on "Fractures and Dislocations." I am indebted to the CLINICAL SOCIETY and to MR. MORRANT BAKER for Figs. 245, 246, 247, illustrating Charcot's disease; to MR. BOWLBY for Figs. 50 and 54; to MR. GREIG SMITH for several illustrations of the various methods of suturing the intestine;

of the illustrations, nearly two hundred in number, were (with four exceptions) drawn from original specimens by my brother, Dr. J. A. MANSELL MOULLIN (to whom I am indebted for the article on Diseases of the Female Generative Organs) or myself.

I have also to express my thanks to Mr. J. HUTCHINSON, junior, for his chapters on Diseases of the Skin and Eye; to Mr. T. MARK HOVELL, for that on Diseases of the Ear and Larynx; and to Mr. F. S. EVE for that on Tumors.

C. W. MANSELL MOULLIN.

# EDITOR'S PREFACE.

Moullin's Text-book on Surgery was introduced into this country two years ago, and its favorable reception by the Profession soon caused the exhaustion of the edition.

Its wide scope, its clear expression, and its excellent illustrations made it a favorite; and these characteristics have been preserved in the American edition now offered. The work has undergone thorough revision wherever necessary, and many new illustrations from the most recent Foreign and Domestic Monographs have been added, and such changes in the text have been made as recent changes in Theory and Practice required. Some rearrangement has been made of the text, and a brief chapter on the outlines of Military Surgery has been added. To make room for the new matter and new illustrations, without materially increasing the bulk of the book, certain portions of the former chapters on diseases of the skin, diseases of the eye, diseases of the ear and larynx as were not strictly Surgical, have been omitted. Among other additions, the chapter on amputations has been enlarged by the addition of a number of new illustrations, and Surgical Bacteriology has been newly illustrated by colored engravings from recent monographs.

The additions made by the Editor are enclosed in brackets.

The Editor feels sure that this excellent work of MOULLIN in its American dress will continue to enjoy the popularity in this country which the first edition so well merited and received.

Thanks are due Passed Assistant Surgeon Wertenbaker, M. H. S., and Dr. D. Bevan, of Jefferson Medical College, Philadelphia, for a number of carefully made drawings that increase the value of the book; and to Drs. W. A. Wells and W. M. Barton for assistance in preparing the index.

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# PART I.

# GENERAL PATHOLOGY OF SURGICAL DISEASES.

## CHAPTER I.

*INJURY AND REPAIR.—INFLAMMATION.*

### INJURY AND REPAIR.

The immediate effect of an injury is to kill some of the structures upon which the brunt of the violence falls and impair the vitality of others, the extent and severity of the damage sustained depending partly upon the intensity of the agent, partly upon the condition of the tissues. As soon as the irritant ceases to act repair begins, provided the violence has not been so great as to destroy life altogether; if it continues, or if, before its effects have died away, a second is inflicted, impairing vitality further still, what is known as inflammation follows. Two things, therefore, have to be considered in estimating the effect produced—the severity and persistence of the irritant, and the condition of nutrition of the tissues.

#### Of the Various Causes of Injury.

Irritants are divided into two classes, the organized or living, and the unorganized, which may be mechanical, physical, or chemical. The distinction is not a logical one, as the former act either mechanically, by blocking the blood-vessels, or chemically, by means of certain poisons they produce; but it is convenient for this reason, that the one is endowed with an independent existence, and the other is not.

##### 1. *Organized Irritants.*

Certain animal parasites (such as the chigoë) are occasionally met with living in the tissues, but they are so rare as to be of comparatively little consequence; the more important ones are microscopic, unicellular organisms belonging to the class Schizomycetes, multiplying by transverse division, and, in the case of the rod-like forms, by spores as well.

*a.* Of these some can only live in dead material. They are constantly present in the bronchi and the alimentary canal, they enter freely with the food and the air; but even if they are injected into the blood they are either killed [by phagocytic action of the leucocytes] or eliminated with the urine; they are non-pathogenic, they do not of themselves give rise to any disease. Such, for example, are the bacteria of putrefaction. These cannot exist in the tissues so long as they are alive; but where they gain entrance to a collection of pus or of wound-discharges exposed to the air they thrive most vigorously and form a chemical poison which is the cause of some of the varieties of wound fever. [Rosenbach has cultivated a saprophytic spore-bearing bacillus, and Hauser has found several varieties of the *proteus*.]

*b.* Others can exist in the tissues or in the blood, but are unable to affect injuri[illegible] their power of resistance has been lowered by other local

or constitutional causes. Such are the organisms which give rise to the formation of pus (staphylococcus pyogenes aureus, albus, or citreus, streptococcus pyogenes, and several more); they do not cause specific diseases, but according to the circumstances under which they enter, and their surroundings, they are followed by suppuration, gangrene, pyæmia, noma, phagedæna, and other acute inflammatory disorders.

*c.* A third class again is specific, being followed invariably by the same definite disorder. Some of these are attended by local inflammation (tubercle, syphilis, erysipelas, glanders, anthrax, etc.); others, such as tetanus and hydrophobia, give rise to constitutional symptoms only.

### 2. *Unorganized Irritants.*

***Mechanical***, such as cuts, bruises, friction, or tension. A simple incised wound heals at once, without inflammation. Certain tissue-elements are killed; a very slight amount of blood is extravasated between the cut edges, but if there is no further hurt or injury the natural process of repair begins at once. If the blood decomposes, if the wound is repeatedly rubbed, or if a suture is put in so tightly as to cause tension, a fresh injury is inflicted, the vitality of the surrounding tissues is lowered, and inflammation sets in and continues until the irritant is removed.

***Physical.***—Heat acts in the same way. A cautery plunged into a nævus leaves a hole with blackened, charred edges; but if no fresh irritant is allowed to appear the wound is repaired without inflammation. A burn covered up thoroughly from the air and protected from decomposition heals without further trouble, unless pyogenic or other organisms gain access to it in some way. Intense local cold produces the same effect. How a general chill acts when it causes internal inflammation (pneumonia, for example) is not certain.

*Chemical.*—The same may be said of these. Nitric acid applied to the skin forms a scab under which repair is completed without further destruction or loss of tissue. If, however, a continuous stream of poisonous compounds is poured into the blood, or allowed to act upon the tissues, the most intense fever and the most widespread destruction may follow.

It is still open to question whether the nervous system can of itself excite inflammation. There is no doubt that a part of the body separated from the central organs is especially liable to become inflamed if it is injured in any way; but this is not the point. It seems probable that certain disorders—herpes zoster, acute bedsores, and some forms of arthritis—are the direct result of affections of distant portions of the nervous system, and that, therefore, nerve-irritation must be regarded as a direct exciting cause; but in what way it can act must remain undefined until more is known of the influence of the nerves upon the nutrition of the tissues during health.

## Of the Influence of the Condition of the Tissues.

The effect produced by an irritant depends not only upon the irritant itself, but upon the condition of the tissues. In old age, where the arteries are atheromatous and the circulation feeble, or after prolonged exposure to cold, a scratch or bruise so trivial that under other circumstances it would scarcely have attracted attention may lead to the death of the part it affects, and by the changes that follow prove the cause of extensive gangrene.

I. The circulation may be defective. There may be a deficient supply of blood, or the part may be engorged and congested. Everything that tends to prevent a fair amount of blood flowing to a part—arterial atheroma, cold, strangulation, as in the case of a hernia or Esmarch's bandage, if too long applied—lowers its vitality and renders it less able to resist injury. In the same way, if there is any difficulty to the return of blood—if, for example, the veins are vari-

cose and the tissues congested and œdematous—the most feeble irritant may cause a very extensive degree of inflammation.

II. The quality of the blood may be defective: leucocythæmia, Bright's disease, scurvy, or diabetes may be present. It is probable that gout, intemperance, starvation, and possibly rheumatism also act in this way.

III. Interference with the nerves going to a part undoubtedly predisposes to inflammation, but whether this is a direct result, or indirect, due to the fact that no work is done and that, consequently, the nutrition of the part is carried on without energy, is uncertain.

Besides these causes there are others, many of them hereditary, concerning which it is impossible to say more than that the tissues themselves are peculiarly susceptible, sometimes to every kind of irritant, sometimes only to certain special forms, such, for example, as tubercle.

### The Effect of a Single Injury.

The immediate effect of an irritant of more than the slightest degree of intensity is to kill some of the tissue-elements and lower the vitality of the others. Unless the blood-vessels are ruptured, so that there is some extravasation, the change that actually takes place is, for the most part, beyond our power of observation; it is known that after powerful electric shocks the corneal corpuscles and wandering leucocytes cease their movements and become fixed in shape, and probably the same result is produced by other irritants of equal degrees of intensity; but even of this it is impossible to say more than that the living protoplasm has undergone a process of coagulation. The interchange of oxygen and carbonic acid comes to an end; the plasma ceases to circulate in the interstices; fibrin-ferment is set free; coagulation takes place; and the injured part is converted into a semi-solid mass of dead albuminous material, of itself perfectly inert. If the irritant is not sufficient to produce the full effect and kill the tissues, the changes are probably the same in direction, but not carried so far.

The effect upon the blood-vessels is of exactly the same character. At first, unless the irritant is a very powerful one, there is a momentary contraction of the arterioles and capillaries, but this is not constant and is probably not important. As soon as its influence fairly reaches the muscular fibres and the endothelial cells that form the walls, the tonic contraction relaxes, the vessels dilate, and the part becomes loaded with blood. For the first few moments the speed of the stream is slightly increased, owing to the capillaries not dilating to the same extent as the arterioles, but this does not last long. Some of the living cells are killed or badly hurt; the normal relations between the blood and the walls of the vessels no longer hold good; the colorless corpuscles, which always have a tendency to lie on the outside of the current, accumulate in greater numbers and cling more closely to the damaged structures; they stick for a time at one spot, and when they do move seem as if they were being dragged away; and many of them pass through the wall and collect in the interstices around. Then the plasma becomes more viscid; the stream becomes slower and slower; the red corpuscles in the axis oscillate a little, and finally come to a standstill. In other words, *stasis* sets in. The circulation stops; the part is full of blood, and after a time *thrombosis* occurs, coagulation taking place in the vessels as well as in the tissues.

The injury has lowered the vitality of the cells that line the vessels and form their wall, and now they act toward the blood like any other dead or dying structure. The changes are the same as in the tissues; the blood ceases to circulate in the one, and the plasma in the other; some of the cells are killed; the ferment is set free; coagulation takes place; and fibrin is formed, only, owing to the presence of red blood-corpuscles in the one, the appearance is much more striking and more easily recognized than in the other.

Such an effect as this may be produced by any simple kind of injury, mechanical, physical, or chemical. A bruise kills some of the subcutaneous tissues and

causes a slight extravasation of blood; a clean, incised wound, the edges of which are at once brought together again, does the same. The actual cautery, plunged, for example, into a nævus chars some of the tissues round, and for the time impairs the vitality of those farther off. A ligature tied tightly round the stump of an ovarian tumor stops the circulation through it mechanically and leads to the same result; and, on a larger scale, the same thing occurs in one form of senile gangrene; the tissues are slowly starved to death, and the part gradually becomes hard and mummified.

The subsequent changes, always provided no other irritant is allowed to appear, are equally simple.

I. The tissues that are killed either undergo fatty degeneration, or are dried up, according to their position. In the former case they gradually disappear, being absorbed by the living structures around; in the latter the deeper part may be absorbed, but all the hardened structures are thrown off, a new layer of epidermis being slowly developed beneath them, so that the surface is once more restored.

II. Those around that are only slightly injured recover by degrees and begin the process of repair. For this, however, the general nutrition must be fairly good; if their vitality is already low, not only is the extent of the original injury far greater than it otherwise would be, but they may not have sufficient power to rally, and then the area of destruction spreads.

*Repair.*—Repair is merely an expansion of the natural process of nutrition. All the interstices of the tissues are everywhere filled with plasma, which pours out through the walls of the blood-vessels and drains off by the lymphatics. Each living cell draws from the general stock around it what it requires for itself, and gives up that for which it has no further need. When it is worn out, or when, from injury or any other cause, it is brought to an untimely end, it is removed and replaced, either by the development of fresh ones from the survivors near, or by the agency of the leucocytes which wander freely through the channels. The rapidity of the current is regulated by the amount of work to be done. Where the activity is unusually great, and the amount of work exceptional, as after an injury, the plasma pours through more freely, the blood-vessels dilate, the blood circulates more rapidly, more food is brought, and the waste is removed more quickly. If, on the other hand, a part of the body is kept at rest and does no work, whatever the cause may be, the plasma remains stagnant and the tissues starve.

If the injury has been a slight one, not sufficient to kill any of the tissues, perfect restoration is the rule. The red blood-corpuscles separate from each other and fall off into the circulation, almost, if not quite, unchanged; the endothelial cells recover their natural tone; the vessels regain their calibre; the plasma loses its viscid character, just as incipient rigor mortis may pass off, and the colorless corpuscles cease to collect against the wall or pass through in excessive numbers.

If it has been more severe, so that some of the tissue-elements and of the cells in the walls of the vessels are killed (with or without extravasation), and the plasma has coagulated, the process is not so simple; a certain amount of new tissue must be formed, to replace that which is lost. The injured area now is transformed from a living part of the body into a mass of dead and dying cells, held together by a network of fibrin. The circulation has ceased, the capillaries are plugged, and sometimes, owing to the giving way of their walls, the interstices are filled with blood. Such a condition as this occurs after every bruise and on the surface of every wound, even if the edges are brought together at once, the lymph forming a soft but tenacious clot which helps to check the hemorrhage and glue the parts together until permanent repair is effected. This is carried out mainly, if not entirely, by the leucocytes.

Normally, in all the tissues there is a certain proportion of free corpuscles wandering in the plasmatic canals, removing what is broken down and perhaps

replacing it. After an injury, especially one of this severity, these increase immensely in number, pouring through the walls of the vessels and spreading into all the spaces round. In the centre of the injured area, where stasis has occurred, this is only possible to a slight extent; but all round, where the tissues are only slightly hurt, and farther away, where they are not hurt at all, but only stimulated to increased exertion by the presence of injured structures near, these leucocytes pour out in myriads, removing and replacing what is dead, and advancing (forcing their way in reality) farther and farther toward the centre, until the whole injured area is transferred into a mass of living corpuscles.

In the case of small extravasations, this transformation is most conspicuous. At first there is merely a dark-colored clot of fibrin entangling the red corpuscles and a few of the white ones in its meshes; the serum drains away and is carried off by the lymphatics. Then the red corpuscles undergo disintegration; the coloring matter soaks out of them and stains all the tissues near, the *debris* and the fibrin remain behind. Soon the outside of the clot is perforated by numbers of living leucocytes, many of which may be seen to contain fragments of colored ones in their interior. Gradually this change extends farther and farther toward the centre, until by degrees the whole mass is consumed, and nothing is left but the leucocytes which have replaced it.

These changes are not without their effect upon the parts around. More work has to be done; a greater amount of blood is required, and consequently all the neighboring vessels dilate, the temperature of the part is raised, the skin is reddened if it lies near the surface, there is a certain amount of tenderness on pressure, and a certain degree of swelling, caused not only by the extravasation, but by the increase in the quantity of the blood and the circulating plasma that the part contains. Further, the quantity of waste and dead material to be absorbed is larger than usual, and, as a consequence, the temperature of the whole body is slightly raised, for there is evidence to show that the ferment set free when the tissues undergo disintegration acts upon all the heat-producing centres. All the nutritive changes, in short, are carried on with more than the usual degree of energy.

The next step is the formation of fresh blood-vessels. It is possible that when the injured area is exceedingly small, the leucocytes may derive sufficient nourishment from the circulating plasma; but if it is of more than the most minute dimensions, and new vessels are not formed, the young cells near the centre starve and undergo fatty degeneration. In all cases they develop from pre-existing capillaries. Conical processes spring from the walls, and grow out among the masses of leucocytes, until they join other processes or other vessels. At first they are solid, but even while they are growing a hollow makes its appearance at the ends, and gradually spreads farther and farther until there is a minute central canal down the whole length. This enlarges sufficiently to admit the red corpuscles; then nuclei appear in the wall; and a perfect capillary is formed, ready itself to become the starting-point for others, until the mass of growing leucocytes is supplied with loops of vessels, spreading into it from all sides and converging toward the centre. This is known as *vascular granulation-tissue*, from the peculiar appearance it presents when it is formed upon the surface of a wound exposed to the air; by it all the broken-down tissue and extravasated blood are removed, and from it is developed the newly formed tissue which is to replace the old.

Many of the corpuscles of which it is composed closely resemble pus-corpuscles, and probably, like them, are dead. They are round, motionless, slightly granular, with a bifid or trifid nucleus, which becomes more distinct on the addition of acetic acid. These disappear, very possibly consumed by those around. The living ones are larger, with clear oval vesicular nuclei, and, from the resemblance they bear to epithelial cells, are sometimes called epithelioid.

Organization always begins near the normal tissue, where the effect of the irritant is scarcely felt. The living cells enlarge, become spindle-shaped or

branched, and range themselves in bundles alongside or round the vessels (*fibroblasts*); then their borders and ends become fibrillated, other fibrils make their appearance in the matrix between them, many of the nuclei disappear, others persist as small oval corpuscles, and a little mass of fibrous cicatricial tissue is formed, abundantly supplied with vessels. A few multinuclear giant-cells may generally be found, formed either by the division of nuclei without proportionate partition of the cell-body, or by the blending and coalescence of contiguous corpuscles. When the process is very chronic and the vessels few in number, as in the case of infection with tubercle, the tendency to their production is very much greater.

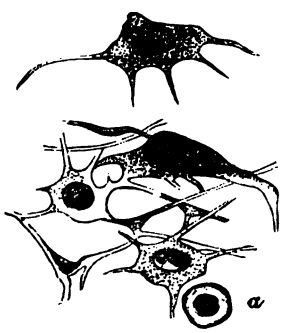


FIG. 1.—A group of fibroblasts in different stages of growth. *a*, embryo cell wandering. (After *Golding Bird*.)

The process of organization after a single injury gradually extends through the whole thickness, beginning at the circumference and converging toward the centre, until the whole area of granulation-tissue is transformed. If the injury was an open wound, modifications naturally take place for the production of a protecting layer of epithelium, but this will be dealt with later. The newly formed tissue at first is highly vascular; by degrees, however, the bundles of fibrils contract more and more, and obliterate the vessels to a great extent. In simple injuries the amount is always small—the minimum, in fact, required to remove and replace what is dead, and the degree of contraction is never serious. When, on the other hand, the tissues have been extensively destroyed by suppuration, the quantity may be so great, and the tendency to contract so inveterate, as to cause the most serious deformity.

### THE EFFECT OF CONTINUED IRRITATION.

A transient irritant, not sufficiently severe to kill the tissues, after its first effect has subsided, acts as a stimulus on all the structures round; they begin at once to act with greater energy, and strive their utmost to repair the damage that has been done. The same thing occurs when the irritant is a persistent one—the tissues throughout keep doing their best to repair the injury inflicted on them; but there is this great difference, that in this case the irritant, instead of being a thing of the past, is hard at work the whole time, sapping the vitality of all the structures near, and diminishing their power of resistance. The whole time the irritant continues there is a contest between it, on the one hand, and the tissues on the other. These, by increasing the amount of the exudation that pours out through the walls of their vessels, keep striving to repair the damage already done, and to check the progress of the injurious agent, whatever it may be; while this, so long as its power lasts, is engaged in destroying the exudation, weakening the tissues, and impairing their vitality. The sum of the changes produced in the conflict is known as inflammation; as soon as the irritant ceases to act inflammation ceases and repair begins.

### SYMPTOMS OF INFLAMMATION.

These are the same as those already described, but they are very different in degree. Redness, swelling, heat, and pain are present, as before, to a greater or less extent; the functional power of the part is lowered, and the temperature of the blood is raised; but this is no longer within physiological limits: now the changes are pathological, kept up by an irritant which is all the while at work, either impairing the vitality of the tissues, and causing inflammation, or killing them.

In inflammation of a superficial part all these signs are usually present and

equally well-marked, and the diagnosis is clear; in other cases, however, especially when the part is deeply seated and the irritant of low intensity, there may be only one, and then the difficulty is very great. In such, a diagnosis can often be made only by a process of exclusion, or by actual exploration.

**Redness.**—The color may be brilliant, returning instantaneously if driven away by pressure, or livid and almost purple, as round the margin of old sinuses. In severe cases the blood-vessels give way, leaving ecchymoses, which after a time (especially if they are repeated) turn a dull red-brown. A pigment-stain produced in this way lasts for years, particularly when it is upon the legs. If, as in periostitis of the femur, the inflamed part is deeply seated, the color of the skin remains unaltered, or is even whiter than natural, from being stretched by the effusion beneath.

**Swelling** is never absent, although if the part is thickly covered in, it may not be detected. At first it is due simply to the distention of the vessels; but this is insignificant in comparison with the exudation that follows. The rapidity with which it forms and the degree of firmness it presents to the touch, depend upon the anatomical arrangement of the tissues and the character of the exudation. The more open the tissue, the more quickly it takes place and the softer it feels. Structures, therefore, like the eyelids or scrotum, easily assume enormous dimensions. On the other hand, when the exudation is bound down beneath a layer of dense and close fibrous tissue, such as the periosteum or the deep cervical fascia, it may be, for a time at least, as dense and resistant as bone, although if firm pressure is used, it will always yield a little, forming a sharply defined pit which slowly fills up again.

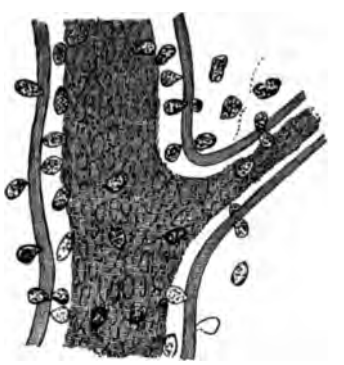

FIG. 2.—Diapedesis.

The character of the exudation varies with the nature and intensity of the irritant. It may be *serous*, with but few leucocytes and little tendency to form fibrin—almost the same, in short, as that which is present in health; this is chiefly met with when the cause is a distant one—round the extreme margin of an abscess, for example. It may be *sero-fibrinous* or *fibrinous*, consisting of little but a meshwork of fibrin formed from the plasma and enclosing the leucocytes in its meshes. Or it may be *sero-purulent* or *purulent*, when, owing to the peptic action of pyogenic micro-organisms, no fibrin at all is formed, but only a mass of albuminous liquid, with dead and dying pus-corpuscles floating in it. Distinct examples of all of these are seen in serous and synovial cavities, but they are of frequent occurrence elsewhere, especially in the meshes of connective tissue.

When the irritant is very intense, the walls of the capillaries perish, and the exudation becomes *hemorrhagic*. When, on the other hand, it is slight but persistent, as in the case of tubercle and syphilis, masses of *granulation-tissue*, with giant and epithelioid cells, are developed. Sometimes, after lasting a considerable time, this becomes absorbed; more frequently, according to the cause, it either becomes organized, undergoes degeneration and caseation, or breaks down into pus. From this peculiarity these diseases are sometimes known as infective granulomata, granulation-tissue being produced in masses of such size that they resemble tumors.

**Heat.**—The temperature of an inflamed part is nearly always raised; the only exceptions are the very chronic cases (and in these it is probable that a thermopile would detect some slight variation at one time or another); and some of the very acute, in which, owing to the early occurrence of stasis, the current of blood flowing to the part is greatly reduced—in short, in incipient gangrene. It is stated to be due, not to the increased local production of heat, but to the increased supply of arterial blood raising the temperature of the part almost to that

of the interior of the body. Of course this may be far above the normal. Care must be taken, when estimating the temperature of any part, to compare it, not with the normal temperature of the body, but with the actual temperature of the corresponding part, placed under exactly the same conditions of clothing and exposure.

**Pain.**—The severity depends upon the degree of tension. In acute inflammation of tough, fibrous structures, or where, as when bone is concerned, there is great resistance to expansion, it is exceedingly severe, and is made infinitely worse by anything that increases the current of blood in the part—allowing it to hang down, for example, or using it in any way. Under these circumstances, especially when suppuration is imminent, it is often described as throbbing, each throb corresponding to a beat of the heart, and to a fresh amount of blood driven into the part.

The character of the pain depends more upon the tissue concerned; thus bones and ligaments ache; the skin smarts and burns; and the eyes become intolerant of light. In very severe cases the pain may cease altogether toward the end, owing to the failing power of the brain.

**Impairment of the function** of the part is often one of the most valuable

FIG. 3.—Stomata of the Capillaries. (After *Duplay and Reclus.*)

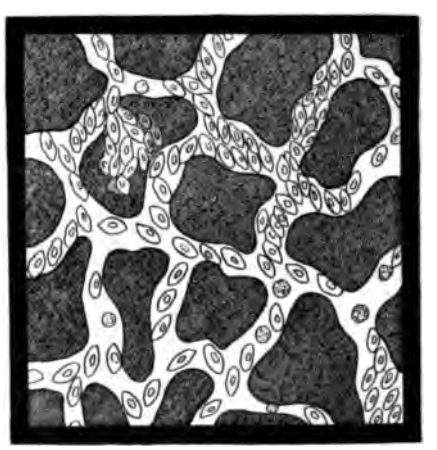

FIG. 4.—Dilatation of Capillaries.

signs; an inflamed joint, for example, is held rigid by the muscles, and cannot be moved to its full extent in any direction. In the same way absorption and secretion cannot be carried out if the mucous membrane of the bowel is inflamed, and peristalsis is stopped if the serous and muscular coats are attacked. All work increases the amount of blood in the part, causes varying degrees of tension to fall upon the tissues, and makes the pain and inflammation more severe.

**Fever.**—In addition to these local signs, inflammation is always attended by a certain degree of fever. The temperature of the body, which normally ranges from 97.5° to 98° in the early morning, to 98.5° and even 99° of an evening, is raised; the pulse is quick and hard; the respiration is hurried; the tongue and mouth are dry; the appetite is lost, and all the secretions are diminished. The skin is hot and parched, the urine is scanty and high-colored, and the bowels constipated. Sleep is disturbed; headache is always present; delirium is usual (especially at night) when the temperature is raised more than three or four degrees, and the loss of flesh and strength is rapid and extreme.

The cause of this fever is mainly the increased production of heat; in comparison the diminished loss by the skin from the absence of evaporation is altogether insignificant, and this increase results from a greater degree of activity in

metabolism of the parenchymatous tissues of the body, the muscles and glands in particular. So much is clear from the rapid emaciation and loss of strength, and from the increase in the amount of carbonic acid and urea eliminated.

The way in which this increased metabolism is brought about is not so definite. In all probability the changes that take place in the tissues are under the control of the nervous system; it seems likely that the supreme centre is in the cortex of the brain, probably in the parietal region; that there is another in the medulla oblongata; and, as in the case of the vaso-motor system, others still—subsidiary ones—in the spinal cord. Possibly also, carrying the analogy further, the tissues themselves are not altogether devoid of influence, at any rate when isolated from the main command. In fever it is believed that normal control over the metabolism is enfeebled, and that the tissue-changes are carried on at a much more rapid rate, with increased production of heat as a natural consequence. This undue activity of the metabolism is, in some cases, excited by peripheral stimuli; tension, for example (even such an apparently trivial matter as a suture drawn too tightly), is undoubtedly a very powerful stimulus, although it must not be forgotten that it helps as well by promoting the absorption of fever-causing substances from the tissues. Mental emotion is another, and possibly this explains some of the mysterious cases of local hyperpyrexia. By far the most powerful cause, however, is the absorption, through the blood or through the lymphatic system, of certain products, which either weaken the control of the nerve-centres that preside over metabolism, or stimulate the tissues to increased change. In other words, pyrogenous agents, as they are called, act either directly or reflexly upon the heat-regulating centres in the central nervous system, impairing their power of control; or upon the tissues themselves, stimulating them to increased activity.

Of substances that possess this power there is no lack. Broken-down blood-clot, even when a wound is subcutaneous, is one, the active constituent being, so it is said, the fibrin-ferment. The products of putrefactive fermentation possess it in a very much higher degree, causing septic traumatic fever or sapræmia, according to the nature of the ptomaine produced, and the quantity that enters the circulation at once. Many varieties of infective germs are still more active, multiplying in the tissues and the blood-stream, and forming substances which cause the most severe constitutional symptoms; and in all likelihood the fever that accompanies simple inflammation (not due to putrefaction or to any infective germ) is mainly caused in the same way, partly by tension, but chiefly by absorption through the lymph-stream of substances produced in the tissues under the action of various kinds of irritants.

The character and severity of the fever depend upon the cause. Age is of some influence, as during childhood, when the metabolism of the tissues is most active, sudden and severe attacks are not uncommon after very slight causes. Sex, and what is known as temperament, may also have a certain effect. In the chronic forms of inflammation it is very slight; in acute ones it may be *sthenic*, *asthenic*, or *irritative*.

In the sthenic form the symptoms are acute, the temperature high, 104° or 105° F., and the pulse full, strong, and bounding. The onset is usually sudden, and often marked by a shivering fit or rigor, or, in the case of children, by an attack of vomiting or convulsions.

The asthenic may either succeed to this, or may commence as such, quietly and insidiously. Sometimes it is attended with sloughing, but in many cases the local signs are very slightly marked. From the first, what are known as typhoid symptoms set in; the patient lies overcome with stupor, or in a condition of low muttering delirium; the skin is hot and dry; the face dusky and pinched, with sunken eyes; there is sordes on the lips and teeth; and the tongue is dry and brown, or red and cracked. Diarrhœa is often present, the motions being passed unconsciously; and frequently there is albuminuria. The pulse is small and quick, and the respiration hurried and shallow, but the temperature is rarely very

much raised, and it may even be subnormal, especially toward the end. Th variety is only met with where the patient's health is utterly broken down fro intemperance or other causes, or where an irritant poison is absorbed in overpowe ing quantity, as in septic peritonitis following operation.

Irritative fever is less well-marked; one chief characteristic is the earl occurrence of delirium, and the prominence of the nervous symptoms.

The fever is said to be *continuous* when the daily variations do not exceed a F.; if it is greater than this it is called *remittent*. In the *intermittent* form the are periods (which may or may not be regular, and which vary greatly in dura tion) during which the temperature does not rise above the normal.

### Varieties of Inflammation.

These are the signs common to all forms of inflammation; they are an indica tion of the changes that take place in the living tissues while they are being irr tated by some cause not sufficiently powerful to kill them, and they occur in a alike, so far as structural conditions allow. In part they are the direct effect c the injury lowering the vitality of the tissues upon which it is acting; in pa they are due to the efforts at repair made by the living (uninjured) element around; if the irritant is the stronger, destruction progresses more or les rapidly, and the fever is high, and the part red, swollen, and painful; as it influence begins to wane and the tissues gain control, this diminishes, and whe its action ceases, the fever and the other signs disappear altogether; there is noth ing then to hurt the tissues further, or prevent them regaining their forme activity; all pathological changes come to an end, and the natural process c repair removes all trace of morbidity so far as is possible.

The extent of the changes in inflammation depends upon the condition c the tissues on the one hand, and the intensity of the cause on the other. Th character depends upon the nature of the irritant.

A very trivial injury, for example, may give rise to the most serious conse quences if the nutrition of the tissues is enfeebled from disease or intemperance but mechanical irritants can only cause simple inflammation; suppuration canno occur without pyogenic organisms, and tubercle cannot appear without its specifi bacillus. The tissues, in their endeavor to limit the action of the irritant always produce the same exudation, but the changes this undergoes under th influence of different irritants, and under different conditions, naturally differ an give rise to different varieties of disease.

A so-called croupous or diphtheritic exudation is occasionally met with upo the surface of granulating wounds. It forms a buff-colored rind which may b peeled off easily, leaving a raw surface, which usually heals readily if brushe over with nitrate of silver or iodine. Sometimes, however, it is reproduced agai and again, and it may extend, to a serious degree, especially on burns. Probabl it is due to coagulation-necrosis, caused by the action of certain germs, involvin the exudation and, in the diphtheritic form, the tissues themselves sometimes to considerable depth. True diphtheria very rarely attacks wounds; when it doe it is usually caused by direct infection (though, curiously enough, tracheotomy wounds are seldom contaminated), and the clinical symptoms and sequela resemble those of the ordinary form, allowance being made for the difference i locality.

[**Summary.**—Inflammation is due to irritation of the tissues by livin organisms, chemicals, or mechanical violence; its symptoms are redness an swelling with heat and pain (Celsus), and its pathological anatomy shows th stages of hyperæmia, stasis, and diapedesis.]

### Simple Inflammation.

The causes are mechanical, physical, or chemical irritants, sufficiently severe to injure the tissues without killing them outright; a suture, for example, drawn too tightly, a burn or scald exposed to the air, constant friction, or long-continued irritation by dust or smoke. The symptoms are those already described: redness, swelling, heat, and pain, with impairment of function and fever, varying according to the size and importance of the part involved, and the acuteness of the attack. They may be so intense as to endanger life, or so slight as to be scarcely perceptible.

Simple inflammation may end fatally, or undergo resolution, or become chronic. The exudation may become absorbed, organized, or undergo fatty degeneration. Suppuration is a complication due to the action of certain micrococci.

(*a*) ***Death*** may be caused by the intensity of the fever, by exhaustion, or by the organ that is attacked being essential to life, as in the case of the glottis or the heart.

(*b*) ***Resolution.***—If the nutrition of the part is good, this begins as soon as the cause is removed. The pain and fever cease; the temperature of the part, although still above that of the corresponding one, owing to the amount of blood it receives, is well below fever heat; the swelling disappears, except so far as it is caused by the increased flow of blood and plasma necessary for repair; and the redness loses its angry tint, although the blush persists for many months if new vessels have been formed. The amount of granulation-tissue and scar-formation depends upon the extent of the disease. It may be so little as to be practically imperceptible, as after a bruise or a simple incised wound, or it may be of any extent.

(*c*) ***Persistence.***—If the cause is frequently repeated, or if, without being too severe, it continues to act, the inflammation persists and is very liable to become chronic. This is especially likely when constitutional predisposing causes, such as gout and rheumatism, are present; the attack commences with some slight irritant, such as would not be noticed if the tissues were healthy, and the morbid state of the nutrition is sufficient to prevent resolution after the original irritant has ceased to act.

### General Principles of Treatment.

Inflammation is the result of an injury sufficiently severe to impair the vitality of the tissues without killing them outright. The first thing, therefore, is to prevent, as far as possible, the access of any irritant (preventive treatment), and the next to remove any source of injury that may be present, to strengthen and maintain the nutrition of the tissues, and to place them under the most favorable conditions for resisting and overcoming anything that affects them injuriously.

#### 1. *Preventive.*

A single uncomplicated injury is not followed by inflammation: the process of repair begins at once, and if there is no other irritant and the damage is not too extensive, is completed without the surrounding structures suffering in the least. Inflammation is the result of continued irritation—either local, such as that caused by the presence of foreign bodies, by tension, friction, want of rest, or putrefaction; or constitutional, resulting from some morbid condition of the blood or tissues, as in gout. The preventive treatment, therefore, except in so far as it is possible to improve the nutrition of the tissues and place them in a more favorable condition, practically resolves itself into the treatment of wounds and other injuries.

#### 2. *Curative.*

1. **Removal of the Cause.**—Foreign bodies must be removed; tension relieved by dividing sutures, making incisions, and providing the freest possible

drainage; and friction prevented by absolute rest. Pain must be allayed, and any irritant in contact with the surface, whether it is an over-powerful antiseptic or the products of putrefaction, either removed or rendered innocuous. Sometimes, when the inflammation is due to the action of a powerful local irritant, as in phagedæna, the surface must be destroyed, and occasionally certain drugs are employed which may possibly act directly upon the cause—mercury, for example, in syphilis, and colchicum in acute gout.

2. Where the cause cannot be removed, the symptoms must be treated. In other words, an attempt must be made to regulate the quantity and quality of blood flowing through the part, so that the nutrition of the affected tissue may be maintained as well as possible.

The means at disposal are local and constitutional.

### *Local Remedies.*

**Rest.**—The more the part is used, the greater the amount of blood flowing to it and the greater the tension. To be of any use, however, the rest must be complete.

**Position.**—The effect of allowing an inflamed limb to hang down is well known. Raising it assists the venous and lymphatic circulation, and at the same time lessens the amount of blood entering it, by causing a vaso-motor constriction of the arteries.

**Pressure.**—Uniform, gentle, and elastic pressure, such as that produced by investing the part with many thicknesses of cotton-wool, and then placing a bandage over the whole, is a most efficient method for diminishing pain and tension even in cases of phlegmonous inflammation. In a few instances pressure has been applied to the main artery of a limb with the same object, and the femoral has been ligatured in cases of acute inflammation of the knee-joint.

**Cold** is a most powerful agent for checking the amount of blood flowing through a part. It may be applied either by means of an ice-bag, or by Leiter's coils of leaden tubing, arranged to fit closely round. In other cases, lead and spirit lotion is allowed to drip slowly over the part and evaporate, the surplus being carried off by means of properly arranged rubber sheets beneath. It checks protoplasmic movement, lowers the vascular tension by causing paralytic dilatation of the walls of the smaller vessels (at first there is a temporary constriction), and if applied continuously and with sufficient vigor, can stop the circulation altogether. In some cases, as for instance with tubercle-bacilli, it possesses the power of retarding development, but, at the same time, when carried far enough for this, there is great danger of its depressing the vitality of the tissues too. It may always be used in the early stages of inflammation, and very often throughout in the sthenic form, especially when the local symptoms are well-marked (as, for example, in quinsy) with a view of limiting the hyperæmia and, if suppuration occurs, reducing the size of the abscess; but in the asthenic form it should always be avoided. An icebag laid along the course of the main artery at a distance from the seat of inflammation is sometimes of considerable value.

**Warmth** acts in the opposite way; it stimulates amœboid movements, causes the walls of the vessels to dilate, and gives freer passage to the blood. Applied to the spot itself it diminishes the tension in the tissues, and in the early stages may procure resolution; but if suppuration is imminent it only encourages it. Advantage is taken of this when it is wished to make an abscess point. When used over a more extensive surface, it diverts a larger portion of the blood that would otherwise flow through the inflamed area, and, by relaxing the tissues, facilitates the return through the veins and lymphatics.

Whether heat or cold should be applied locally may be left, to some extent, to the patient's feelings, but not altogether. The former is usually selected, as it diminishes tension and pain more quickly; but if the latter is continued for a little time, especially when the inflammation is acute and sthenic, the relief is,

generally speaking, much more complete. Whichever is chosen, the application must be continuous; any intermittence, especially in the case of cold, makes matters infinitely worse.

[The late Professor Allen explained that either heat or cold, *continuously* applied, is a *sedative; intermittently* applied, a *stimulant.*]

**Astringents** are chiefly used over the surface of mucous membranes. Lead, however, if applied to the skin for any length of time, becomes absorbed (as shown by the discoloration) and acts directly upon the capillaries and small vessels.

**Local bleeding** in acute inflammation is of the greatest service, although it is very difficult to explain why. It cannot be the amount withdrawn, for this is usually altogether insignificant. Leeches may be used (not, however, over any loose tissue, such as the eyelid or scrotum; in orchitis they must be placed on the groin); superficial veins may be punctured; or small incisions made here and there in the axis of the limb, taking care to avoid any important structure. The last method is especially useful in phlegmonous inflammation of the cellular tissue, when there is any danger of sloughing, to relieve the tension on the skin. The bleeding may be encouraged afterward, if necessary, by means of a warm bath.

**Wet-cupping** is rarely practiced now; but dry-cupping may be employed with benefit in inflammation of deep-seated organs such as the kidneys. The air in a cupping-glass is rarefied by holding it like a bell over a large spirit-lamp, or by burning a small quantity of spirit inside, and then the mouth is quickly pressed against the skin, taking care not to burn the patient. As the air condenses, the tissues rise up in a convex dome, partly filling the cup, the cutaneous vessels become distended, and many of the smaller ones rupture.

**Counter-irritants.**—Rubefacients, blisters, Scott's dressing, and the actual cautery are chiefly of use in the chronic forms. In all probability they act reflexly upon the deeper vessels, as the mere local dilatation and exudation can have but little influence. Belladonna (the extract mixed in varying proportions with glycerine) is sometimes applied with benefit over very large areas. There is no fear of too great absorption through the skin, but abraded surfaces must be avoided. It causes a slight temporary constriction, but this is soon succeeded by a more permanent dilatation, lowering the tension and relieving the pain.

### *Constitutional Measures.*

**Diet** is of great importance. The waste in all forms of inflammation is very rapid, and at the same time the appetite and the power of digestion are very much impaired. Solid food is out of the question in acute cases. Light diet, milk, beef-tea, arrowroot, and other farinaceous foods, jelly, milk-puddings, and the like, are sufficient in cases of sthenic inflammation of short duration. If, however, the attack is of long duration, or if, as in erysipelas, the area involved is extensive, the strongest meat-jelly, eggs beaten up with milk, brandy, and egg mixture, peptonized foods, and similar substances that are easily absorbed, must be given in small quantities at frequent intervals, even when the patient is young and was previously healthy. In older people, and those whose health is broken down, nourishment is still more imperative; and it is then that stimulants are of value, enabling the patient to make the most of what is taken with the least exertion. Great care, however, is required not to overdo it.

Fluids are given throughout as required. Fragments of ice may be sucked from time to time, to allay the parched condition of the mouth, but it must be remembered that a considerable quantity of water is swallowed in this way. Barley water, lemonade, and acid fruit drinks are often very grateful, and, in moderation, do no harm.

In the more chronic cases—in tubercular inflammation of joints, for instance—a great deal may be done toward improving the quality of the blood, and the gen-

eral nutrition, by means of good food, fresh air, tonics, and especially cod-liver oil. Sea-air in these cases is often of wonderful benefit, enabling the tissues to resist the action of the irritant until a less susceptible time of life is reached.

**Bleeding** is rarely practiced, although in cases of acute suppurative arthritis, or in pneumonia, when the other lung is becoming engorged, it is sometimes of great use, especially in young adults, the fever falling at once. In children or patients past middle life its ultimate value is very doubtful, although it may appear to help in tiding over a crisis.

**Purgatives.**—In inflammation the bowels are nearly always constipated, and their action is followed by great relief. If the mucous membrane of any part of the alimentary canal is involved, this is different; but in incipient peritonitis, with effusion, mild purgation has been strongly advocated. It must be remembered that the patient, as a rule, is taking only a small amount of food, and that of such a nature as to leave little residue, so that the constipation may be apparent rather than real.

Aconite (one minim every five minutes until a distinct effect is produced upon the pulse) and antimony (given at frequent intervals until it causes nausea) are sometimes given in young subjects at the commencement of an acute attack (when the heart is sound) with a view of producing general vascular depression. The latter drug is also used in smaller doses during the course of the fever, for the sake of its action upon the skin, and is frequently given for this purpose in conjunction with Dover's powder. Opium is often required internally as well as locally, for the relief of pain or to procure sleep; chloral, bromide of potassium, or strontium and sulphonal are chiefly of use as sedatives or hypnotics. If the temperature is very high, quinine, antipyrin, or salicylic acid is advisable, and the first named appears to possess the power of checking an incipient rigor. In hyperpyrexia cold-sponging, an ice-cap (Leiter's coils, arranged so as to fit the head, form the most convenient appliance, although a simple ice-bag made of thin rubber may be used) or even an ice-pack may be required; but meanwhile, and for some time afterward, close watch must be kept upon the pulse, as sometimes, in these cases, the cardiac muscle fails rather suddenly.

In some cases of high temperature alcohol has been given with considerable benefit. The condition of the pulse and of the heart is in general the best guide to its administration. It is not required in sthenic inflammation of short duration in young subjects; but in asthenic forms attended with sloughing and great depression, especially in old people, it must sometimes be given very freely to tide them over a critical period. In smaller quantities it is of great service in assisting digestion and enabling the patient to make the most of his food with the least expenditure, particularly during convalescence. Carbonate of ammonia in five-grain (.30) doses is especially useful when the tongue is dry and brown and the pulse is beginning to fail in strength and volume. Ether may be given at the same time. Mercury is used, and with benefit under many different conditions; as a purgative at the commencement of an attack; as an alterative, particularly in children, in the form of hyd. c. cret., or pulv. pil. hydrarg.; in all stages of syphilis, more especially the early ones; and locally, sometimes, as a counter-irritant. Colchicum, alkalies, iodide of potash, salicylate of soda, and other drugs are of benefit in special cases; and tonics, especially iron, quinine, and cod-liver oil, are usually required during the period of convalescence.

### Chronic Inflammation.

Acute inflammation may become chronic merely from frequent repetition, even when the tissues are healthy and without predisposition of any kind. Each time, for example, a loose cartilage is caught between the bones of the knee-joint, it gives rise to an attack of synovitis; before the first one the tissues may have been perfectly healthy, and if it is the only one they may recover completely: if however, the injury is constantly being repeated, so that there is no ti-

perfect repair, organic changes are left, nutrition is permanently impaired, and the synovitis becomes chronic.

Constant friction acts in the same way; the conjunctiva, for instance, becomes roughened and granular; the neck of a hernia hard and dense as cartilage; and even the skin may be entirely altered in texture. In the same way the mucous membrane of the throat, instead of remaining soft and flexible, becomes covered with irregular elevations, and seamed with superficial cicatrices as a result of persistent chemical irritation of slight intensity.

Chronic tension leads to a similar result. A leg in which the veins or lymphatics are obstructed slowly increases in size, and becomes affected by what is known as solid œdema, from the resistance it offers when pressed by the finger. The exudation becomes organized; the amount of lowly developed fibrous tissue increases; the muscles waste; the skin is thickened, bound down, and hard, and at length a condition practically equivalent to elephantiasis is produced.

Predisposing causes are of especial importance in connection with chronic inflammation. If they are strongly marked, an acute attack is almost sure to become chronic, whether the exciting cause is repeated or not. A single abrasion, for example, is sufficient in the case of a leg which is congested from long-standing venous obstruction. The skin is badly nourished; in certain places—just above the ankle, for example—it is scarcely able to hold its own; if the cuticle is rubbed off, or a tiny vein gives way, or, in short, if there is the least injury, such as in any other part of the body would not attract attention, inflammation sets in, the already weakened cells and fibres perish, and then, because of the presence of these dead structures, or the friction of the clothes, or the tension due to the very slight addition of blood to the part, it becomes chronic. The least cause is sufficient to depress the vitality of the tissues around and to prevent resolution.

In gout and rheumatism, which are among the most common causes of chronic inflammation, the conditions are much the same. In each the nutrition of the tissues is so gravely involved that a very trivial cause gives rise to an acute attack, and sometimes the predisposition is so strong that an exciting cause is scarcely needed. At first the attacks subside and recovery is, to all intents and purposes, complete. After a time, however, the reparative power of the tissues becomes more and more impaired, the natural condition is never regained, and the inflammation becomes chronic. The predisposing causes have grown so strong that they are not only able to originate an attack with the very slightest assistance, but to maintain it, too.

### *Symptoms.*

The general symptoms are the same as in acute inflammation, but much less severe. Increased heat is often scarcely to be detected; the redness is always slight, although brown discoloration from long-standing hyperæmia is often present, especially upon the legs, where gravity favors stasis; and the pain more frequently takes the form of a continuous wearying aching, with every now and then a more severe spasm; but even when suppuration occurs, it never assumes a tense, throbbing character. In the same way the fever is slight, and the loss of function much less noticeable, partly, no doubt, because other structures compensate for it, and the patient has had time to become accustomed to it.

With swelling, however, the case is different. Exudation is always present, but only a small proportion of it is fluid; nearly the whole is composed of organized elements, many of them escaped leucocytes, but many more developed from the living cells in the tissues round. Whatever may be the case in acute inflammation, whether or no the tissue-elements take any share then in the production of the exudation, in the chronic form there is no doubt they do, and to a very considerable extent. Sometimes the part is greatly increased in size; but not unfrequently, owing to retrogressive changes, its bulk is actually diminished; either the exudation, after replacing the natural structures, itself undergoes degeneration and disappears, or it becomes organized into a lowly developed form

of cicatricial tissue, which contracts, strangling the natural structures, and rendering the organ it infiltrates hard, dense, irregular, and contracted.

Organization is the prominent feature of the chronic inflammation that occurs in rheumatism. The articular ends of the bones are covered with dense irregular nodules; the shafts in some cases are immensely thickened and hardened; the fibrous tissue round the joints is toughened and rigid, and a similar change is met with in connection with the nerves, the walls of the arteries, and, in fact, any connective-tissue structure that is attacked. In chronic gout the ultimate effect upon the exudation is complicated by the addition of deposits of urate of soda.

In some of these affections, in which the prominent feature is an immense overgrowth of the connective-tissue type, unaccompanied by pain, increased temperature, or fever, it is exceedingly difficult to draw a distinction between chronic inflammation and hyperplasia, especially as the remedies upon which reliance is usually placed here fail completely. Ostitis deformans is an example, and some of those cases in which the lymphatic glands are immensely enlarged without undergoing any definite alteration in structure. It is more than questionable, however, whether an attempt at such a refinement could succeed. In either case there is an impairment of nutrition, resulting generally in increased size, and always in imperfect development of the part, and caused by some morbid condition of the tissues or of the blood. It is not possible to say whether this is to be regarded as the result of an irritant injuriously affecting one particular tissue, and acquired during life, or of some natural impairment born with the individual, and probably transmitted to him from his ancestors.

### *Treatment.*

The principles of treatment in chronic inflammation are the same as in the acute form, but the details vary considerably.

1. **Removal of the Cause.**—In some few cases a definite exciting cause can be found and removed; a sequestrum, for example, may be lying locked in the medullary canal of a bone, unable to escape; or a band of lymph may be left tying down the margin of the iris. In the majority, however, the reason, if not for the outbreak, at least for its persistence, is to be found in the presence of some constitutional affection which does not admit of such speedy treatment. Mercury, given in small doses and for a sufficient length of time, may possibly act on the syphilitic virus as a specific, destroying it, or at least prevent it from having any further influence; but very few other drugs possess this power. Potassium iodide, though it will remove the effects, certainly cannot stop recurrences, and the same may be said of colchicum in gout, and the salicylates and alkalies in rheumatism. They relieve the symptoms for the time; the exudation disappears and the pain diminishes; but the cause is too deeply seated in the nutrition of the tissues to be removed in this way.

2. **Improvement in Nutrition. General.**—Many of the exciting causes are of very slight intensity; and it often happens that if only the general nutrition can be a little improved, the tissues gain strength enough to deal with the irritant themselves. It is to this improvement, consequent upon the entire change of life and habits, that so many of the foreign bath resorts owe their reputation in gout and rheumatism; and the effect produced does not subside at once.

The particular line adopted varies, of course, with the complaint. With gout the diet should be sparing and light; stimulants are better avoided, at any rate in the earlier periods of the disease; the bowels should be kept fairly open, and any accumulation of uric acid in the blood prevented as far as possible by abundance of fluid, combined with the moderate use of alkalies. Chronic rheumatism, on the other hand, is chiefly benefited by residence in warm, dry climates; woolen clothing; nutritive but unstimulating food, and the prolonged use of baths, especially sulphur ones, combined with internal administration. Tonics, particularly cod-

liver oil and iron, are often of use at the same time to combat the condition of anæmia which is frequently present. By measures of this kind not only is the immediate attack checked and cured, but the tissues are so built up that they are better able to resist injurious influences of the same character afterward, in spite of the general rule (which is especially true of this variety of inflammation) that one attack predisposes to another.

**Local.**—This must be guided very largely by the temperature of the part. Subacute attacks, in which the heat is considerable and the pain severe, should be treated as if they were acute; but where the temperature is normal, or almost normal, those measures answer best which maintain an increased but uniform supply of blood. Warmth by itself is beneficial, but alternating with cold it produces a much greater effect. Pouring water down from a height, douche-jets, and needle-baths are exceedingly powerful, and are chiefly of use where the inflammation is past and only its effects remain. The same may be said of friction, rubbing, and massage. Carried out efficiently these have immense influence upon the circulation; the lymphatic spaces are emptied, the effete matter pressed out, the flow of plasma through the tissues quickened, and the nutrition greatly improved.

Counter-irritants are of the greatest use in chronic inflammation, both for the relief of deep-seated pain and the diminution of tension by the absorption of the exudation. Rubefacients, vesicants, and even the actual cautery are employed, according to the depth of the structure it is desired to affect and the duration of the attack. How they act is uncertain, but that the effusion disappears, especially when they are repeated at frequent short intervals, there is no question. Setons, and other methods for causing continued suppuration, are rarely used now.

Mercury and iodine are supposed to possess a special action in promoting the absorption of the products of chronic inflammation; but, apart from the results they produce as counter-irritants, and in syphilitic affections, it is doubtful if they are not overrated. Potassium iodide, however, has a very considerable effect upon vascular tension. Superficial forms of inflammation—on mucous membranes, for example—are sometimes benefited by the action of local astringents; and when there is a considerable degree of effusion, as in chronic synovitis, pressure, in conjunction with counter-irritation, may be applied with great advantage.

## CHAPTER II.

### *DISEASES DUE TO NON-INFECTIVE ORGANISMS.*

Of these there are only two—septic fever and sapræmia.

These diseases are caused by the absorption from the surface of a wound of certain poisons produced during the fermentation or decomposition of albuminous liquids. Probably they are ptomaïnes, analogous to the bodies formed in the alimentary canal. If they enter the blood, they act as virulent poisons, the severity of the symptoms depending upon the amount of the dose; and they may cause a fatal result within a few hours. On the other hand, they do not multiply in the blood, which therefore is not infective if it is inoculated; they are excreted slowly by the kidneys (ptomaïnes, probably formed in the alimentary canal, are found in the urine and saliva), and if the patient survives the first effect and the dose is not repeated, the constitutional symptoms gradually subside. There is no incubation period, and, other things being equal, a large wound, or one that exposes a large absorbent surface, such as the peritoneum, is much more likely to be attended with a severe attack than a small one.

#### Septic Fever.

Subcutaneous injuries in which decomposition (in the sense of putrefaction) never takes place are often followed by a certain degree of fever, due either to tension or to absorption from the seat of injury of some of the products of tissue destruction, of which the "fibrin-ferment" is one, and, perhaps, the most important. It sets in very shortly after the injury, attains its maximum within twenty-four hours, and then, unless some other irritant is present as well, begins to fall again. In addition to this, however, wounds that are exposed to the air are liable to be followed by another and more severe disorder caused by absorption from the surface of the products of decomposition.

This does not commence for some days, generally two or three after the injury; then it rapidly attains its maximum, persisting for three or four more, and at the end of the fifth or sixth, if the wound is thoroughly drained, the tissues healthy and well nourished, and no complication arises, begins to subside again. Naturally, septic fever rarely occurs by itself; in by far the majority of cases it follows the true traumatic fever before this has had time to disappear, and in its turn is followed by that which accompanies suppuration.

At the commencement there is often a feeling of chilliness, but rarely a distinct rigor; nausea and vomiting are not unusual; there is headache, with extreme depression; the temperature rises to 102° or 103° F.; the skin is hot and dry, the face flushed, the bowels confined, and the tongue thickly furred. The appetite is completely lost; the pulse is full and rapid, and, especially in the case of children and people with an excitable temperament, there is often slight delirium at night. The edges of the wound are red and swollen; the skin for some distance around is exceedingly tender and very hot; while the surface, if it is visible, is probably covered over with grayish-yellow sloughs, and discharges a thin, turbid, and somewhat offensive fluid.

**Treatment.**—The first thing is prevention. If it is too late for this, further decomposition must be stopped, either by irrigation with an antiseptic, or, better, by placing the part, if it can be done, in an antiseptic bath; but I have known a sloughing wound of the hand remain for three days in a corrosive sublimate bath (1 in 5000, renewed every three hours) without the smell being over-

In addition to this, the absorption must be stopped as soon as possible by the most thorough drainage and by encouraging the wound to secrete. Warm fomentations and warm baths are especially grateful; the tension is relieved; the throbbing pain subsides; the blood circulates more easily; the plasma and the leucocytes pour out more freely through the walls of the vessels; the process of destruction ceases, and a barrier of vascular granulation-tissue is formed, to throw off dead cohering fragments and prevent the absorption of any more of the poison. If the tension is completely relieved, the temperature falls to normal; if, on the other hand, the discharge is retained, it rises regularly of an evening, assuming the remittent type as suppuration follows, and gradually passes into hectic.

Constitutional treatment should not be neglected, but so long as the cause continues at work, it can give but a very small measure of relief.

### SAPRÆMIA.

Sapræmia, or septic intoxication, is the name given to the most intense variety of septic fever. It occurs under the same conditions and is caused in the same way—by the absorption from the surface of a wound of some ptomaïne formed during fermentation. Probably the particular variety is not always the same and certainly putrefaction, with the formation of offensive gases, is not necessary. Clinically, it is probably very rarely met with by itself; but, like the preceding, it is present as a complication in all extensive wounds, especially those in which a large amount of blood is allowed to accumulate and undergo decomposition exposed to the air.

Substances of a similar character are formed in the decomposition of preserved meats, sausages, and the like, and when swallowed cause all the symptoms of violent irritant poisoning—vomiting, purging, etc., followed by profound collapse, coma, and, if the dose is sufficient, death within a very few hours.

The constitutional symptoms resemble to some extent those of septic fever, but they are much more severe. In most cases, those especially in which putrefaction is present, the wound is acutely inflamed; but I have known it, after an amputation through the knee-joint, progress, to all appearance, as well as could be wished, while the patient's temperature was gradually rising higher and higher and the pulse becoming weaker and more feeble. The only local sign to attract attention was the presence of a thin serous discharge in enormous quantities. Much more frequently, however, putrefaction is present, and various forms of infective germs as well.

The pathological appearances present no distinctive feature of any kind. The blood either does not coagulate or else forms a loose, soft, black clot which readily breaks down. The lining of the vessels and the endocardium are often stained, and sometimes marked by actual ecchymoses, which also occur on the serous surface of the viscera, and at times in their interior. The spleen is enlarged and softened; the liver and the lungs are congested; the structure of the viscera, on section, is confused and blurred, especially in the case of the kidneys; and the mucous membrane of the alimentary canal is frequently in a condition of acute inflammation, especially if the poisonous substance has been swallowed. When it is slowly absorbed from the surface of a wound, intestinal lesions are not usually present in man, though they are not uncommon in the case of animals. Decomposition after death, as in many other forms of septic diseases, is unusually rapid.

At the commencement there is usually a rigor or an attack of vomiting: the temperature sometimes rises rapidly, without any apparent reason, to 104° or 105° F.; sometimes, on the other hand, especially in the more severe cases, it rises a little at the first, and then falls again, even becoming subnormal. The pulse is quick and feeble, the respiration hurried and shallow. The extremities are cold, while the trunk, perhaps, is burning hot; the tongue is dry and brown, and the and teeth covered with sordes. Diarrhœa, with blood-stained stools, is usually

present in artificially-produced sapræmia, but is not frequent in man. As the ter perature rises the patient becomes delirious; the prostration is extreme; the pul is almost imperceptible; the forehead becomes covered with perspiration; tl face grows more and more dusky, and at length, if the dose is sufficient, or if is repeated, the patient sinks into a state of collapse, and the heart fails cor pletely.

**Treatment.**—The local treatment, as in the case of septic fever, consi simply in thorough drainage, combined with the use of antiseptics. If the wour is on one of the extremities, nothing is more successful than a corrosive sublima bath (one part in 5000); if this is impracticable, it should be thoroughly ir gated, great care being taken not to injure the surface. The object is to preve further fermentation and absorption; if this can be accomplished, and tl patient's kidneys are sound, so that the poison is eliminated, the prognosis good, in uncomplicated cases. Unhappily, sapræmia is usually merely an add tion to other even more serious affections.

It has been suggested that where any definite nervous symptoms are preser which it is known can be counteracted by the action of other alkaloids—dilat tion of the pupil, for example—an attempt should be made in this direction but cases in which this would be practical must be very rare. After the acu symptoms have subsided, the anæmia and exhaustion left must be combated l iron, tonics, and a nutritious diet.

Affections similar to septic fever and sapræmia are stated to have been caus by the injection into the blood of pepsin, trypsin, and other unorganiz ferments.

[SURGICAL (Traumatic) fever is the designation applied to the ephemeral fev which frequently appears after a wound or injury. It is due either to the absor tion of minute debris of tissue necrosis or to their oxidation.

INTESTINAL TOXÆMIA is a term used to designate a condition in which tl ptomaïnes of putrefaction are absorbed from the intestinal walls, and thus ent the circulation. Metastatic abscesses may arise in this way. Intoxication fro this source with pyrexia may be confused by the observer with sapræmic ar septicæmic processes.]

# CHAPTER III.

## *DISEASES DUE TO INFECTIVE ORGANISMS.*

Pathogenic organisms are divided into two distinct classes, specific and non-specific. The former are always followed by the same disorder under whatever circumstances they occur, whether they cause local and constitutional symptoms (anthrax, syphilis, etc.), or constitutional ones only (hydrophobia and tetanus); the latter, the non-specific ones, according to the modes of infection and the condition of the tissues, give rise to a variety of diseases—suppuration with its consequences, hectic and albuminoid degeneration, ulceration, gangrene, phagedæna, pyæmia, and many others.

### 1. NON-SPECIFIC.

### SUPPURATION.

It is still open to question whether suppuration can occur from merely mechanical or chemical irritants, however persistently they act. As a matter of fact, as Ogston was the first to show, certain forms of organisms—staphylococci or streptococci in the vast majority of cases—are invariably present in acute abscesses, whatever share they take in their causation.

They enter either through a wound or through the mucous membranes, and travel by means of the lymphatics or blood-vessels. Some (staphylococci for the most part) lead to circumscribed abscesses; others (streptococci) spread by the lymphatics and are followed by diffuse suppuration. If the tissues are healthy they can do nothing—either they are killed or discharged in the urine. (It has been suggested that some are got rid of by the medium of the parotid, thus offering an explanation of the extreme frequency of what has been called parotid bubo after operations and in the course of pyæmia; but it is at least equally possible that the organisms enter the gland through the duct.) If, however, they are arrested in a part the nutrition of which is impaired by injury of any kind—mechanical, chemical, or physical—particularly if there is any extravasated blood; or if, as in pyæmia, they are present in such numbers that whole districts of capillaries are simultaneously plugged, further changes take place in the surrounding tissue and suppuration begins.

The effect is most characteristic in cases of simple inflammation. The blood in the centre of the affected area has ceased to move; in the rest of the vessels it is circulating very slowly; the plasma round the injured cells has coagulated, and all round the tissues near are in a state of immense activity; the vessels are dilated, the volume of plasma is increased, the number of free leucocytes is greater than ever, and every effort is being made by the developing granulation-tissue to absorb and replace the damaged structures. Suddenly a mass of staphylococci is brought to the part, either through a wound or the blood-stream. In the stagnant plasma and among the injured tissues they find a most favorable soil; the structures among which they lie at once begin to lose their distinctness of outline, the fibres swell up, become homogeneous and almost translucent; the leucocytes perish, and a ring of what is called coagulation-necrosis forms round the mass of germs and spreads wider and wider. After a time the centre becomes liquid, and then a minute abscess is formed, lying in the middle of the inflamed tissues. Many of these small foci are usually situated close together, and, as they extend and widen, the intervening barriers soon break down.

Meanwhile, the tissues farther away from the irritant strive to protect themselves by throwing out a wall of lymph. At first, while the infection is still active,

this melts away as rapidly as it is produced, the leucocytes perish and drop off as pus, and the *debris* of the tissues and the plasma (which is prevented from coagulating by the ptomaïnes) add to the amount. By degrees, however, the activity of the germs decreases, the wall of living leucocytes grows thicker, new vessels are developed from the dilated ones around, and at length a "pyogenic membrane" [limiting fibrine] is formed and the spread of the suppuration is checked. It rarely happens, however, that it is stayed altogether. Owing to the extreme hyperæmia in all the parts near, the tension of the fluid in the interior is unusually high, and, aided by this, the action of the germs remains sufficiently powerful to continue the destruction in the direction of least resistance. Sometimes, owing to the presence of dense sheets of fascia, the pus spreads laterally for immense distances among the tissues; but sooner or later its course turns toward the surface, the skin or mucous membrane, as the case may be, gives way, and the abscess breaks and discharges its contents.

[The law in regard to the "pointing" of an abscess is that pus is forced to the surface in the line of least resistance.]

When the nutrition of the tissues is impaired by intemperance or prolonged residence in foul air, in pyæmia, and during convalescence from exhausting illness, suppuration sometimes occurs without local injury. The capillaries are plugged with micro-organisms at some small spot, and the walls of the vessels themselves are the first to perish and melt away. In such cases as these, or when the streptococcus pyogenes gains early access to the lymphatic spaces and spreads through them before the tissues can resist, a pyogenic membrane is never formed; the suppuration *is diffuse;* the strength of the tissues is so enfeebled that they disappear before the invading germs, unable to protect themselves by a barrier of any kind.

### Abscess, or Circumscribed Suppuration.

Abscesses are acute or chronic, according to the intensity of the symptoms by which they are attended and the rapidity with which they spread. The latter are probably due to the same causes as the former, acting under less favorable conditions. Those, however, that result from the softening and liquefaction of masses of caseous material must be distinguished; they are always associated with the presence of specific germs, and for a long time, at least so long as they are chronic, do not contain true pus. It must be admitted that it is not always easy to draw a definite line between them.

Pus from an acute abscess in an otherwise healthy person is a thick, creamy, opaque, yellowish-white, or greenish fluid, with an alkaline reaction and a specific gravity of 1030 to 1035. Its color is due to the presence of small quantities of altered hæmoglobin; when it is red and mixed with blood it is known as *sanious;* if it is thin and watery it is called *ichorous*, and *curdy* when mixed with flakes of caseous material. Sometimes, when it comes from a mucous membrane, it is known as muco-pus; it may be *infective* from the presence of micro-organisms, and sometimes *specific* when it conveys the germs that give rise to definite diseases. In the neighborhood of the alimentary canal it not unfrequently has a peculiarly offensive odor, although there is no direct communication, and the same thing is often noticed in connection with dead bone. In a few rare instances its color is blue, owing to the presence of a special organism (*bacillus pyocyaneus*).

[This bacillus resembles the blue-milk bacillus (*bacillus cyanogenus*) and belongs to the semi-anaerobic species. According to Ernst, there are two varieties of this organism, the second having a green pigment.]

Pus consists of pus-corpuscles mixed with germs, floating in a highly albuminous fluid. The corpuscles themselves are, some of them, identical with leucocytes, and these are alive, capable of amœboid movements, but the vast majority are dead. They are round, slightly irregular on the surface, about $\frac{1}{250}$ of an inch in diameter, and granular. The nucleus is generally bifid or trifid, and sometime

actually divided into two or three. The granules are, many of them, soluble in acetic acid, so that when this is added the outline of the nucleus becomes more distinct; but, after the pus has been some time in existence, they chiefly consist of fat. In very old collections fatty degeneration is complete, the corpuscles are entirely broken up, and nothing is left but a thick, putty-like, caseous material mixed with cholesterin crystals. The germs, for the most part, are streptococci or staphylococci. The fluid, unlike plasma, has no power of coagulating; it contains a large quantity of albumin and chloride of sodium, with small amounts of leucin, tyrosin, and other substances. Lime-salts and phosphates are present to a considerable extent, chiefly in the corpuscles.

When suppuration is very acute, shreds and sloughs, composed of the denser tissues, such as fasciæ and tendons, are usually found floating in the pus; their vitality naturally is low, and the inflammation around them has killed then *en masse*—in other words, they are examples of necrosis and inflammatory gangrene on a small scale. Had they been of looser texture and more vascular they would

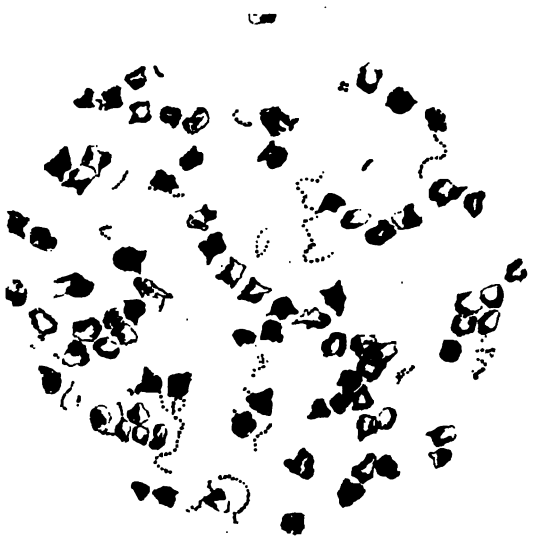

FIG. 5.—Pus from an acute abscess at time of evacuation. Dried and treated with methyl violet. (× 700.) Pus corpuscles, between which may be seen the thin film of coagulated albuminoid material. Pair of micrococci. Diplococcus. Chains of micrococci. Streptococci. Sets of four. Tetrads. (*After Woodhead.*)

have melted away, digested by the peptonizing action of the cocci, and helped to form the albuminous fluid.

**Symptoms.** *Local.*—These at first are the same as those of inflammation, well marked in the acute form, very indistinct in the chronic ones. Then, as fluid begins to make its appearance, the character of the *swelling* changes. At the commencement, if it is near the skin, it is bright red and firm to the touch; the surface is shining and pits on pressure (*inflammatory œdema*) and the depression so formed is well defined and is slow in filling up again. By degrees, as the foci run together and the pus begins to collect, the centre becomes softer and more dusky, the abscess is pointing; then the skin near the middle, where it is most undermined, bulges out a little, the cuticle peels off, suddenly a small, round opening makes its appearance, and the pus is discharged. In many cases, shortly before this happens, a soft circular spot with sharply defined edges, marking infallibly the part through which the pus will appear, is felt on gently passing the finger over the surface.

When the abscess is of any size, the existence of fluid is detected by what is termed *fluctuation*—the wave felt by the fingers of one hand when pressure is made with the other upon a distant part. With large collections of fluid this can be made out at once, the amount of the displacement is so great; but with small ones, especially when they are deep-seated or tied down by unyielding sheets of fascia, it is often a matter of extreme difficulty. At the same time it is impossible to overrate its importance. The further apart the fingers of the two hands can be placed the better. The pulps, not the tips, should rest upon the skin; two should be used if possible, but in many instances there is only room for one of each hand; those of the one should maintain a slight but perfectly uniform pressure upon the skin, those of the other should be gently but firmly pushed down at short regular intervals, and before a definite opinion is formed the action should be reversed. Of course, fluctuation, even when the diagnosis is correct, can only be taken as a proof of the presence of fluid; it is no proof of its nature, which may or may not be inflammatory.

In testing a part of the body in this way there are many sources of fallacy. An excellent imitation of fluctuation is obtained over a healthy muscle if the hands are placed side by side upon it, so that the wave is transverse. Soft, solid growths are so perfectly elastic that the same sensation is produced over them, and, though the distinction is of less importance, as suppuration is almost sure to follow, areolar tissue infiltrated with inflammatory œdema often fluctuates distinctly; fluid is actually present, but instead of being confined in one central cavity, it is spread about in the loosely woven and softened network of fibres. In deep-seated abscesses, especially those which are tied down beneath dense sheets of fascia, as in acute periostitis, the œdematous swelling in the looser and more superficial tissue is so great that this false sense of fluctuation is all that can be felt. As, however, in itself it is almost diagnostic of the condition beneath, this is of less importance.

In addition to this, the character of the pain changes as suppuration sets in. *Throbbing* is met with under other conditions, but it is seldom or never absent when pus is forming rapidly, especially if it is tightly bound down, and *tenderness* too often becomes much more distinct and localized.

*Constitutional.—The fever* that attends the formation and discharge of pus is in many respects highly characteristic.

At the commencement this is very often *a rigor* or shivering fit. This begins with a sense of chilliness, or actual cold, which may last only a few minutes, or may continue half an hour. At the same time there is a feeling of extreme prostration. The skin is pale, livid, and rough; the face is pinched; the eyes are sombre and surrounded by dusky rings; the respiration is hurried and shallow; and the pulse small, frequent, and feeble. Even at this time the temperature is higher than normal; the rise begins before the shivering, continues all through it (so that while the teeth are chattering the skin is scorching), and through the period of dry, burning heat afterward, until sometimes it reaches 106° F. As soon as it ceases, profuse perspiration sets in, the temperature begins to fall, the face becomes flushed, the involuntary muscular fibre in the skin relaxes, the natural texture returns, and there is a sensation of profound relief, although the weakness and exhaustion afterward are often extreme. Not unfrequently a herpetic eruption makes its appearance around the lips the day after a rigor, and in some cases spreads over the lower part of the face.

Typical rigors are by no means confined to the onset of suppuration. They occur at the commencement of many of the specific fevers, and in pneumonia and pyæmia. The first passage of an instrument down the urethra may cause one, or the first micturition after an operation. Those who suffer from ague are particularly susceptible to the urethral form, but nothing of the kind has been proved in reference to others. In children vomiting and convulsions occur instead, and in acute catarrhal inflammation, and sometimes in other forms, there is a succession of slight chills, lasting for many hours, instead of one definite one. The ulti

cause is unknown. No doubt, from the symptoms, they are due to the action of the nervous system, the medulla oblongata and the higher centres that control the production of heat in particular, but it is not known what the stimulus is nor how it acts. The suppurative rigor and that which heralds acute specific fevers may be caused by the absorption of some poison into the blood; and Harrison believes that this is true of urethral ones as well, the ptomaïnes present in the urine being absorbed through abrasions of the mucous membrane after micturition; but it is more probable that these are due to reflex irritation, whatever may be the cause of the others.

The subsequent course of the fever in acute suppuration depends upon the amount of absorption. In deep-seated inflammation the temperature frequently continues to rise until the wall of granulation-tissue is established; then it usually drops slightly of a morning (rarely a degree), rising again to its former level of an evening. As soon as the abscess is opened and tension relieved, absorption ceases altogether, the temperature falls to the normal, and if the drainage is what it ought to be, and decomposition does not occur, it does not rise again.

Suppurative fever must be distinguished from septic fever, although the two often occur together.

If the suppurative variety occurs alone, it pursues the course already described, the severity depending upon the tension. Sometimes, therefore, as in thecal abscess or whitlow, although the amount of pus is very small, the constitutional symptoms are exceedingly severe.

If the two are present together they cause hectic, the temperature continues to rise of an evening (although it may be normal of a morning), and the strength of the patient fails until, if the cause is not removed, death ensues from exhaustion.

If septic fever occurs, suppuration is sure to follow, unless the case proves fatal too soon. In a recent wound—a compound fracture, for example—in which the planes of cellular tissue up and down the limb are filled with extravasated blood, traumatic fever sets in first, with or without shock. Then, if decomposition takes place, septic fever follows, the limb becomes red and swollen, the temperature rises, delirium sets in, and the patient may die from acute blood-poisoning before there is time for suppuration. If he escape this, the pyogenic organisms gain access to the part, the tissues, injured already by the action of the septic poison, melt away as pus, and in five or six days the fever begins to assume the suppurative type. After a time, unless the result is fatal in the meanwhile from exhaustion and hectic, the structural elements around regain their strength, a barrier of granulation-tissue is thrown out, the temperature falls of a morning, although it still continues to rise in the evening; and by degrees, if no further injury is inflicted, the suppurating area contracts, the absorption of the products of decomposing pus ceases, and the fever subsides.

### Varieties of Abscess.

*Acute or Phlegmonous Abscess.*—This is usually taken as the type of an abscess. All the symptoms are present, constitutional as well as local, and they are severe in proportion to its size and the degree of tension. Throbbing pain, heat, swelling, redness, and fever are well-marked; inflammatory œdema is always present over it, and fluctuation makes its appearance at an early period, varying, of course, according to the depth. If it is not opened it makes its way in the direction of least resistance, undermines the skin, and bursts; the cavity contracts at once, and unless some cause, such as a foreign body or a piece of dead bone, keeps up the irritation, the granulations fall together as it collapses, and repair is completed in a very short time by their organization.

***Metastatic abscesses*** are a variety of the acute form occurring in connection with pyæmia. They are sometimes described separately because of their distinctly embolic origin; but if the view that suppuration is due to the action of cocci,

conveyed to a distant part of the body, sometimes, at least, by the blood-stream, is correct, the distinction does not appear a material one.

*Caseous abscesses* are due to the breaking down of old, tubercular, syphilitic, or, in rare instances, epitheliomatous deposits. They are most common in connection with tubercular disease of the bone, especially of the spinal column; but they often originate in the lymphatic glands or the subcutaneous tissues—in any place, in short, in which a caseous deposit is found. Cocci are never present so long as they are chronic; and the material they are filled with, although it resembles pus in external appearance, contains very few pus-corpuscles, and consists chiefly of broken-down fatty *debris* mixed with fluid. [In America, in contradistinction to acute abscesses, this form of abscess is generally termed "cold" abscess; it is still an open question whether all these abscesses, without reserve, are tubercular, but that the majority are tubercular none dispute.] Abscesses of this description not unfrequently attain an enormous size without their existence being known. There is no pain in connection with them, nor any fever so long as they are chronic. They are too deep-seated in most cases to cause any redness of the skin or swelling; and it is not until they have lasted, perhaps, for months, and have destroyed the tissues around them for immense distances, that they at length approach the surface. Even then the soft parts over them show no sign of active inflammation. The skin either remains entirely unchanged, or very slowly becomes thinned, reddened, and softened, until at length it gives way. The walls of these abscesses, especially the older parts, are usually dense and hard, containing few vessels, and lined with a layer of cheesy *debris;* they do not collapse and cohere like those of acute ones, and this is one of the chief difficulties in treating them. The cavity, too, is often of the most irregular shape, with large offshoots running in all directions and crossed by bands and septa, many of which contain important vessels and nerves. In short, they are so altogether different from acute abscesses in their contents, character, and behavior, that, except as a matter of convenience, they should not be classed with them. Even their termination is different. It very rarely happens that acute abscesses dry up or disappear. With these this ending is not at all uncommon. The fluid is gradually absorbed; the caseous material becomes more and more inspissated; and at length it undergoes calcification, nothing being left but a dense, chalk-like substance, lying in the centre of a capsule of fibrous tissue.

Unfortunately this termination cannot be relied upon. If left, caseous abscesses for the most part only grow larger and larger, destroying more and more, and becoming more complicated in shape, until either they break, or, from some accidental cause, the cocci of true suppuration gain access to them, and they become acute.

*Chronic abscesses* that are not of tubercular origin are much more rare, but occasionally they are found—in the breast, for example, or locked in the interior of a bone. The irritant that has caused them has been of very slight intensity, and the tissue in which they lie has surrounded them with a capsule so hard and dense that escape is out of the question. Sometimes these, especially when they occur in bone, are the source of severe pain.

*Residual abscesses* are akin to these, although many of them probably are tubercular. Typical ones are met with in old cases of joint-excision. Years after the operation an abscess, often of very large size, forms rather rapidly in the cicatrix. It may be due to an old tubercular focus which has been left behind suddenly waking up again after some slight injury; or to the fact that extensive masses of cicatricial tissue are very poorly nourished, and very prone to break down from trivial causes. The prognosis is always good.

*Cold or congestive abscesses* are usually met with in connection with the lymphatic glands, generally in the axilla or the groin. The patient has been out of health for some time, and has received some slight scratch or bruise. A few days afterward, perhaps, when the original injury is well and forgotten, a certain degree of stiffness is felt, and suddenly a huge swelling is discovered, very soft,

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fluctuating and painless, with but little sign of fever or inflammation. The contents are usually thin and rather oily, and not unfrequently it takes a long time for the patient to recover.

*Tympanitic abscesses*, containing gas as well as pus, are occasionally met with in the neighborhood of the alimentary canal, not necessarily in connection with the intestine, though this is very commonly the case.

*Diffuse suppuration* is only met with when the action of the poison is very intense, or the resistance of the tissues exceedingly feeble, and is usually associated with streptococci, as well as staphylococci. The symptoms of inflammation may be well-marked, but not unfrequently they are altogether concealed, the fever assuming a typhoid or adynamic type, and the nervous system being so overpowered that pain is scarcely felt.

**Diagnosis.**—If the part involved is superficial, and the signs of inflammation are distinct, there is little or no difficulty; when the converse of this is the case it may be impossible. The occurrence of a rigor, the presence of throbbing pain and of inflammatory œdema, a softer spot appearing in the middle of a mass of hardened tissue, and the sensation of fluctuation, are the most important diagnostic signs; but any of these may be absent, or even all of them, and it must always be remembered that fluctuation only indicates the presence of fluid, and of itself gives not the slightest clue as to its nature. In cases of doubt, and particularly where the diagnosis has to be made from cysts or soft solid growths (which may be attended by all the signs of inflammation—hectic, local heat, redness, swelling, and pain), it is advisable to make use of an exploring-needle (grooved so that fluid can escape along it) or a long fine trocar and cannula. Very little harm can be done with either of these, if carefully used; the liver, for example, may be punctured in all directions, almost with impunity; and the result can be relied upon. Even in those cases in which a caseous mass prevents the exit of any fluid, evidence of its presence may generally be found at the end of the cannula when it is withdrawn.

**Treatment.**—1. *Acute abscesses.*—Preventive measures may be tried first; but, as a rule, if there are fair grounds for suspecting suppuration, the sooner an incision is made the better. In cases in which pain is severe and tension high (as in whitlow, acute periostitis, and phlegmonous inflammation of the cellular tissue) it is certainly not advisable to wait. Free incision is the best prevention.

Incision is the only method of treatment. If the abscess is pointing, or if, short of this, there is one spot more tender than another, or at which the skin is more adherent or œdematous, the question of locality is settled. Where there is no indication of this kind either the most dependent part is selected, or that which appears advisable for anatomical reasons. Superficial veins and nerves, for example, should be avoided; natural folds of the skin selected as far as possible; and, above all, especial attention paid to the depth, position, and direction of the more important structures, such as vessels and ducts. If an incision must be made in their neighborhood it should be parallel to them.

No plunge should be made in opening an abscess. The spot is selected, and the scalpel or abscess-knife introduced perpendicularly until either the sense of resistance ceases or, when the blade is slightly rotated, the pus wells up round it. Sufficient length is obtained in cutting outward. Deep abscesses, lying among important structures, are opened either by dissection or by Hilton's method. If, for example, there is suppuration beneath the deep cervical fascia, and the position of the vessels is uncertain, an incision half or three-quarters of an inch in length is made through the superficial structures, and a steel director pushed into the most prominent part of the swelling. As soon as it reaches the fluid a little escapes along the groove. Then a pair of dressing-forceps, with the blades closed, is passed along the director, and the wall of the abscess, and the structures over it, torn as far as may be necessary by separating the handles.

An abscess should never be squeezed; it only makes the granulations bleed. If the sac is small and the tension high the contents are soon forced out by the

neighboring structures; and if the incision is of proper size and in proper position the cavity is obliterated almost at once. All that is required is an absorbent dressing to take up the excess of fluid that is secreted at first, owing to the sudden removal of the tension from the vessels in the newly formed granulation-tissue.

When the abscess is deep-seated or complicated in shape this is not enough. If it lies beneath a layer of fascia, or if the surrounding structures have been much displaced by its pressure, the deep wound, when the tension is relieved, does not correspond to the superficial one. The opening is valvular and the contents cannot escape freely. In this difficulty a drainage-tube must be used.

The best are lengths of red rubber tubing kept ready in a five per cent. carbolic solution. The size selected depends, to some extent, upon that of the abscess and the character of its contents, but, as a rule, the larger the better. Small ones soon become blocked and increase tenfold the danger they are intended to prevent. Nothing is more common than to see a gush of fluid when they are withdrawn. The walls must be flexible, but firm enough to maintain the patency of the interior, and openings must be made in them here and there. The deep end is passed by means of a probe or sinus-forceps quite to the farther limit of the sac; the superficial one is just flush with the skin, and is provided with a ligature to secure it if required. The wall of an old abscess is thick and rigid; the structures around have grown accustomed to its presence, and do not obliterate the cavity when the tension is relieved; and for this reason, unless the freest possible exit is given to the contents by means of a dependent opening and a large drainage-tube, some is sure to remain behind and decompose.

In large abscesses it is advisable to make two openings and pass a drainage-tube through. After two or three days it may be withdrawn, and two, one at each opening, substituted for it. As the structures around recover themselves and become pressed together the middle portion of the sac is obliterated, and when the granulation-tissue begins to contract the tubes are gradually forced out.

Wood-wool or moss, impregnated with corrosive sublimate, is a most efficient dressing, but any other substance that is sufficiently absorbent and capable of preventing putrefaction may be used instead. The dressing should be thick and cover some distance around; the compression helps the abscess to contract, keeps the part at rest, and maintains an even temperature. The frequency with which it is changed depends upon the amount of discharge; in many cases a single dressing is sufficient. The temperature, if the abscess is drained thoroughly, falls at once to normal; if it rises above 99°, at any rate on more than one evening, it is almost certain that the exit is not free.

Metastatic, residual, and cold or lymphatic abscesses present no peculiarities. Chronic ones, locked in bone, naturally require special treatment. If suppuration is diffuse free drainage is even more imperative than when it is circumscribed; it is just possible that relieving the tissues of the additional irritation of tension may turn the scale in their favor, and enable them to throw out a protecting barrier; but it must be remembered that in these cases there is, as a rule, progressive inflammation to deal with as well.

2. *Caseous Abscesses.*—The treatment of caseous or tubercular abscesses requires special mention. An acute abscess, unless there is some complication present, discharges itself of all its contents as soon as the tension is relieved, and organization begins at once. In these, on the other hand, the reparative power of the tissues is very feeble, the walls are dense and rigid, so that they do not collapse, and the caseous *debris*, especially the more solid part, has a great propensity for clinging to the interior. In other words, even when they are small, it is not easy to procure free and efficient drainage; when they are of large size, as in the case of many spinal abscesses, and divided into a series of successive chambers by septa springing from the walls, or provided with offshoots spreading in all directions, the difficulty becomes a very serious one.

Formerly it was the practice to leave abscesses of this kind alone as long as possible, more especially as, in a certain small proportion, the caseous material

gradually dried up, and either became absorbed altogether or converted into a calcareous mass. Now, it is recognized that the earlier such an abscess is emptied the better the prospect of speedy recovery, and the less the risk of its proving ultimately a focus for tubercular dissemination.

Many of them occur under conditions that necessitate special treatment. Such, for example, are the caseous foci found in tubercular epididymitis and in so-called strumous disease of joints. Others—those, for instance, that are met with in lymphatic glands, or in the cancellous tissue at the epiphysial ends of the long bones—may be very briefly dismissed; they should be opened as thoroughly as possible; the lining of granulation tissue, covered with caseous material and infiltrated with tubercle, scraped out with a Volkman's spoon, and iodoform dusted over the interior. The difficulty is in dealing with the large ones, which cannot be treated in this fashion.

Aspiration is harmless, and sometimes succeeds. The instrument ordinarily used is a modification of Dieulafoy's, consisting of an exhausting-syringe or glass receiver, and a trocar and cannula so contrived that the former can be withdrawn and the latter brought into connection with the receiver, without destroying the vacuum. Care must be taken that the instrument is absolutely clean (I prefer to have all cannulæ boiled in liquor potassæ in a test-tube just before using; no oil then is required); the opening should be valvular, and the trocar should reach well into the cavity before it is withdrawn, and the connection established. No attempt is made to empty the abscess; as a matter of fact, it cannot be done; a large amount of the caseous material clings obstinately to the wall, and if it is detached, blocks the cannula, and great care should be taken not to make the granulations bleed, either by bringing the end of the instrument into contact with them, or reducing the tension too rapidly. The vacuum should be maintained as the needle is withdrawn, for fear of its leaving some of the caseous *debris* in the wound. As the abscess is not emptied, the beneficial effect must be due to the relief of the tension; sometimes absorption and condensation follow; much more frequently the cavity slowly refills. If the aspirator is used more than two or three times, the openings fail to heal; a little thin serum escapes from them, the margins begin to ulcerate, and the contents slowly drain away.

Small abscesses are sometimes emptied in this way, or with a trocar and cannula, and then injected with an emulsion of iodoform in glycerine (one in ten), or a five per cent. solution of the same drug in ether. The former is especially recommended, as, owing to its high specific gravity, it sinks down through the caseous *debris* which collects upon the floor, and penetrates to the granulations; but there is some risk of iodoform-poisoning.

Large abscesses—those, for example, in connection with disease of the spine—must be opened and drained. Two incisions are always advisable—one at the most dependent part, the other as near the seat of disease as practicable. Sometimes, when there are large outlying pouches, a third is required. The interior should be explored with the finger, to ascertain, as far as possible, its extent, and whether the disease which has given rise to it is within reach of treatment, but it should not be scraped out, for fear of hemorrhage, and of damaging important structures running in the wall, or across the cavity, or washed out with antiseptics; then, a very large drainage-tube should be inserted, or, if necessary, more than one, and absorbent dressings applied. If the drainage is thorough, the caseous material that clings to the wall is thrown off by the granulations with the serum that exudes from them; the amount of discharge is reduced to a few drachms of turbid fluid, and gradually, as the structures around collapse upon the cavity, all the outlying parts close up, leaving only one sinus, leading, by as straight a route as possible, down to the seat of disease.

When this is not feasible, Hamilton's method of irrigation with chloride of zinc (one part in 200) may be adopted. A rubber tube, with a single opening in the side, is passed across the abscess-cavity; one end is connected with an irrigating can, the other with a receiver, and the fluid (which is quite inert as a germi-

cide) is allowed to flow through, drop by drop, the rate being regulated by means of a stop-cock. After a week, the openings begin to leak, and then the continuous irrigation can be dispensed with; the cavity throws off the inner lining in shreds, and gradually heals up. The object is to place the tissues under the most favorable conditions for getting rid of the noxious material that lines the cavity.

When efficient drainage is impossible, so that there must be some residue of dead, putrescible fluid in the cavity, or Hamilton's plan is unsuitable, Lister's method, or some modification of it, may be used. It aims at preventing the access of the germs of putrefaction, and if it is carried out at all, must be done thoroughly. These micro-organisms (unlike those of suppuration, which can be conveyed from one part of the body to another, and can enter through the alimentary or respiratory tract, and cause the formation of pus whenever they meet with tissues too feeble to resist them) are unable to act on living tissues; they must have dead material at a certain temperature and with a certain amount of fluid—conditions which are perfectly fulfilled in ill-drained abscesses.

The skin over and in the neighborhood of the wound is thoroughly cleansed with an antiseptic (carbolic acid, five per cent., is the usual one), and, if necessary, shaved and purified from any fatty matter that may adhere to it, with ether or some strong alkali. The instruments, the hands of the operator, the sponges, and everything that can possibly come near the wound, are treated in the same way. After the abscess is opened, and the immediate discharge from it has ceased, a drainage-tube is carried down to the bottom, and secured in the ordinary manner, and then special dressings are applied.

The wound itself is covered with protective—oiled silk coated with copal varnish, and brushed over with dextrin. This is dipped in carbolic lotion first. In the case of a recent wound, it is just large enough to overlap the edges all round, and protect the healing surface from the irritating effect of carbolic acid. Over this is laid a dressing of specially-prepared gauze. As a rule, it consists of tarlatan impregnated with a mixture of one part of carbolic acid, four of resin, and four of paraffin; but eucalyptus, salalembroth, and other substances are sometimes used instead. The dressing next to the protective is dipped in a solution of carbolic acid (two and one-half per cent.), because, when dry, the disinfectant is not given off readily, and a particle of dust that had escaped the spray might come into contact with the drainage-tube. Over this, covering the skin for a long distance round, is the superficial dressing: eight layers of gauze (dry, but prepared in the same way) with, beneath the outer layer, a piece of mackintosh cloth, so that the discharge may diffuse itself over the whole without coming into contact with the air at any one spot. Elastic bandages are used round the edges, especially where, as in the groin, there is likely to be any movement; gauze bandages for the rest. If the surface is uneven, or if a large amount of discharge is expected, loose gauze rolled up lightly is placed, as much as may be necessary, between the superficial and the deep dressings.

The dressing is changed the day following the operation, using the same precautions, and taking great care not to lift it up toward the spray, but away from it, so that no unpurified air may enter beneath. Afterward it is left until the discharge is apparent somewhere at the edge; but never for more than a week.

[Another method of treating these large abscesses, is by evacuating the contents through a cannula, then *thoroughly* washing the cavity with warm water, then with iodine water, then injecting iodoform emulsion, then closing the skin puncture with iodoform collodion. In washing the cavity the walls of the abscess must be fully distended to allow the fluid to touch every part. The operation should be repeated from time to time as occasion may require.]

### Hectic.

Profuse and long-continued suppuration is accompanied by a peculiar form of fever known as "hectic." The temperature is perfectly regular, but remittent. In the morning it is normal, or only slightly raised; in the evening it is 102°, 103°, or even 104° F. As the rise begins, always at the same time, there is a sensation of heat and thirst, sometimes preceded by a chill; the face becomes flushed, especially the cheeks, on which there is often a bright red and strictly limited patch; headache comes on, with a feeling of extreme weakness and depression, and the patient is restless and uncomfortable, tossing about in bed, unable to sleep. Then toward morning the temperature drops; there is profuse perspiration, often soaking the bed-clothes; and the patient falls into a deep sleep, which may last till late in the day.

The pulse is always rapid, becoming softer, smaller, and more frequent as the case goes on. Emaciation is extreme; the eyes are sunken and bright, the pupils dilated, the skin anæmic, and the tongue very red, especially at the tip and edges. The urine deposits urates copiously, and diarrhœa is of common occurrence toward the end; the strength fails rapidly; the mind begins to wander; the power of taking food diminishes, and at length death ensues from sheer exhaustion.

The most typical examples of hectic are met with in cases of empyema or of large abscesses connected with the spine or hip that have been imperfectly drained; but it may follow suppuration in any part of the body. It does not occur before an abscess is opened, and there is no doubt that it is due to the absorption from the granulating surface of a substance produced by the fermentation (not necessarily putrefactive) of the discharge. The greater the amount of discharge and the larger the absorbing surface, the worse the fever.

The treatment depends upon the cause; if this can be removed the fever ceases; if it cannot, the course may be delayed, but the end cannot be prevented.

The strength must be supported by nourishing diet, tonics, iron, quinine, and cod-liver oil. Stimulants, especially port wine, are of undoubted use. The diarrhœa must be kept in check by astringents and mineral acids. Opium should only be given as a last resource, to relieve pain. The night-sweats, which are very weakening, can be checked by belladonna; and the formation of aphthous ulcers in the mouth and on the tongue (which are very injurious from the pain they cause in mastication and deglutition) must be prevented by means of borax and potassium chlorate.

Typical hectic, with emaciation, flush, and profuse night-sweats, is met with in connection with many varieties of rapidly-growing malignant tumors. The cause is not known.

### Albuminoid Degeneration.

This is one of the consequences of prolonged suppuration often associated with hectic. It has, however, been known to occur independently of the formation of pus in syphilis and malaria. In surgery, at least, it is usually met with in connection with tuberculous disease of bones or joints, and as a consequence of empyema.

**Morbid Anatomy.**—The liver, spleen, kidneys, and the mucous membrane of the intestines are the parts usually involved. It begins in the media and intima of the small arteries and capillaries, and spreads from them to the connective-tissue elements and the unstriped muscular fibres. The epithelial lining atrophies. The substance of the cells is changed into a firm, homogeneous, waxy material, which appears translucent in thin sections, stains mahogany-brown with iodine, and red with methyl-violet. It is nitrogenous, resembles albumen in many respects, but resists digestion and putrefaction.

**Symptoms.**—The liver retains its shape more or less, but slowly and steadily increases in size until it may reach into the iliac fossa. It is firm, hard, and resistant; the edge can be felt with unusual distinctness; there is no pain or any

apparent derangement of function. The spleen enlarges in the same way. The kidneys show the effect by the alteration in the urine; this increases in quantity, diminishes in density, and in the later stages contains a small amount of albumen and some hyaline casts. The mucous membrane of the intestine does not become involved until comparatively late, when, naturally, emaciation and diarrhœa soon become prominent features.

The aspect of the patient is characteristic. There is a peculiar waxy pallor of the face which is unmistakable, and is of itself sufficient to establish a diagnosis. In addition, the anæmic condition of the lips, the emaciation, and the protuberant abdomen, can usually be recognized at once,

Early removal of the cause has been followed by complete disappearance of all the symptoms, so that, some years after, no evidence of such a change could be detected. If this is attempted, however, it must be done before the disease is too far advanced.

### Hemorrhage into an Abscess.

Capillary oozing is very common; the granulations are exceedingly vascular, and the sudden relief of tension causes some of the thin-walled vessels to give way; but it is very rarely serious. Usually it stops at once on exposure; if it does not, ice may be applied locally and the part well raised. In very bad cases it may be necessary to plug the cavity with iodoform gauze—but this is very likely to be followed by a considerable degree of fever.

Venous hemorrhage rarely occurs except from scarlatinal or diphtheritic sloughing in the neck. In this case the cavity should be thoroughly dried, the hemorrhage being checked meantime by pressure; dusted well with iodoform, in the hope of staying the sloughing, and packed with iodoform wool or gauze; but, especially in the case of the internal jugular, the prognosis is almost hopeless. If iodoform fails or is not at hand, turpentine is probably the most efficient agent.

Arterial hemorrhage may occûr under the same conditions, from ulceration into the carotid, or in the groin from the extension of phagedænic bubo. The latter appears to have been more common in days gone by. Occasionally it is met with on the extremities, from the pressure of drainage-tubes or of sharp edges of bone. Fortunately, the hemorrhage is rarely instantaneous; in nearly every case there is a warning. The treatment varies according to the circumstances. In the neck, if it is in the carotid or one of the branches near the main trunk, this must be ligatured at once. In the thigh, if only a few drops escape, cold and pressure may be applied; but a tourniquet unscrewed must be placed upon the limb higher up, and a nurse or dresser instructed to watch; and if there is the least recurrence, no further delay is admissible. In the leg, amputation is usually required.

The complication is a rare one. I have on several occasions seen arteries lying, exposed and beating, on the floor of ulcers without hemorrhage ever occurring. As the inflammation extends into the coats, the endothelium becomes affected and a thrombus forms. Suppurating aneurisms are by no means always followed by hemorrhage. If, however, there is a foreign body cutting into the wall of the vessel, or if the ulceration is phagedænic, or even septic and diffuse, as in those whose health is broken down from any cause, the destruction may advance too quickly for repair, and then hemorrhage follows.

### Sinus and Fistula.

A sinus or fistula is the suppurating track left by the imperfect healing of an abscess. The distinction between the two is not accurately kept. Strictly, the former has only one opening, and that upon the skin; but so long as there is no communication with an internal cavity or with any of the hollow viscera (such as the bladder), the number is not material. A tubercular abscess, for example, may have two or more, connected by channels running in the subcutaneous tissue. In

the same way a fistula should have two, of which one communicates either with the viscera or with a cavity of some kind; the other may or may not be on the exterior; in recto-vesical fistula, for example, both openings are internal; in the biliary variety, only one; but blind fistulæ (which are identical with simple sinuses) are occasionally spoken of in connection with the anus, on account of the close resemblance they bear to complete ones.

**Causes.**—Non-closure of an abscess is due to the persistence of some irritant: tension, as when the contents cannot escape freely; want of rest, owing to the continued action of muscles—the sphincter ani, for example; the presence of dead bone, tubercular deposit, or foreign bodies introduced from without, and the existence of an obstruction to one of the natural ducts, as in stricture, are the most common. Occasionally fistulæ are caused by actual loss of tissue (especially vaginal ones), or by the presence of malignant growths.

As a rule, a sinus or fistula forms a narrow, more or less tortuous canal, lined with a kind of granulation-tissue which secretes a thin, watery pus. Exceptionally, when it is very short, as between the rectum and the bladder, it is covered with epithelium. The external orifice varies according to the cause; when it is due to dead bone, there is usually a protuberant button of granulations, in the centre of which is a very small opening. Tuberculous sinuses, on the other hand, are surrounded by ragged, blue, and undermined edges. In the case of old fistulæ the opening is not unfrequently depressed and sunken, because of the contraction of the granulation-tissue underneath. The internal orifice is generally well defined, although that, too, may be concealed beneath a flap of mucous membrane.

When of recent formation, the structures that form the wall are soft and yielding; but in old cases, particularly those in which the fistula gives exit to one of the secretions, they become hard, dense, and cartilaginous, so that, even when the cause is removed, healing is almost impossible without something further being done.

**Treatment.**—In recent cases it is sufficient to remove the cause. Dead bone must be withdrawn or scraped away; a stricture must be dilated; if there is not free exit for the secretion, the orifice must be enlarged with a drainage-tube or tent, or by an incision; and if, as in the case of sinuses in the groin, the continual movement of the part prevents healing, pressure may be applied. Even those left by suppurating buboes can be induced to close by the proper application of a truss. In many cases, of course, the removal of the cause entails a serious operation. Fistula in ano, for example, is originally due to an abscess, but its persistence is the result of the sphincter, and this must be divided before the wound can close.

In others in which, without any definite reason being found, the wound refuses to heal, an attempt may be made to stimulate the part, or even, in old cases, to excite acute suppuration. In those cases in which the walls are very thick and dense this is the only way. Injection of tincture of iodine may be tried first, or the introduction of a probe coated with nitrate of silver. If this fails, the granulations may be thoroughly scraped out with a sharp spoon or destroyed with the cautery. Finally, sometimes the only measure of any use is to lay the whole open from one end to the other, partly to place it at rest, partly to destroy the hardened, thickened tissues by causing acute suppuration. Where bleeding is feared, this is sometimes done with an elastic ligature tied as tightly as possible.

Large fistulous openings between hollow viscera, or between one of these and the exterior, very often require extensive and repeated plastic operations.

## ULCERATION.

Ulceration is the molecular disintegration and removal of the superficial structures of the body by the action of certain irritants, just as suppuration is of the deeper ones. An ulcer is the sore formed in the process, and in the same way corresponds to an abscess.

A burn—the actual cautery, for example, applied to the skin—does not leave an ulcer, provided no other irritant is allowed to appear. A portion of the skin is killed; the surrounding tissues at once begin to act with vigor; lymph pours out; new vessels are formed; vascular granulation-tissue is produced in sufficient amount, and the dead part is replaced, more or less perfectly, without a trace of suppuration.

If, however, any further injury is inflicted on the part—if the burn is exposed to the air, so that the dead tissue decomposes, or if the surrounding living parts are constantly rubbed by the clothes, or if they are injured in any other way—inflammation sets in; the pyogenic organisms multiply, molecular disintegration begins on the surface of the body, and an ulcer is produced.

As soon as the irritant ceases and the tissues regain their normal resistance, vascular granulation-tissue is formed as round an abscess, destruction comes to an end, organization begins, and the wound begins to heal. Sometimes this is called a healing ulcer, but the term is an inappropriate one, as the ulceration has ceased.

**Causes.**—The causes of ulceration are the same as those of suppuration, predisposing and exciting. The former include everything, hereditary or acquired, local or constitutional, that can in any way impair the vitality of the tissues; and these are of especial importance when the process is chronic; the latter are the same forms of micrococci that occur in acute abscesses. They generally gain access to the tissues from the surface (sometimes, as in pyæmia, through the blood), and the cells and fibres melt away before them because they are too weak to resist. There is the same contest between the irritant and the power of repair; sometimes one gains the upper hand, and sometimes the other, and, as the case may be, the ulcer spreads or heals. Not unfrequently, especially on the leg, there is scarcely any progress one way or the other for years. The irritant has very little power, but the tissues are so badly nourished that they cannot throw it off; and each winter sees the ulcer slowly getting larger, especially as age advances.

There is the same question as in suppuration—whether long-continued mechanical or chemical irritation can cause ulceration of itself without the liquefying action of the micrococci; but the discussion is even more barren, as they are invariably present.

**Varieties.**—*Simple ulcers* may be compared to acute abscesses, with this distinction—that septic germs, causing decomposition of the discharge, are (unless steps are taken to prevent it) always present with the pyogenic ones, weakening the tissues and preparing the way for their action.

*Specific ulcers* resemble, but less closely, caseous abscesses. These are due to the softening and disintegration of tubercular, syphilitic, and, occasionally, epitheliomatous masses in the interior of the body; but, except in certain rare instances, they do not contain true pus until they are opened. The corresponding forms of ulcers are never the result of unmixed disintegration in this way. In addition to the caseation and liquefaction, septic decomposition is always present, and pus as well, from the presence of pyogenic micrococci.

It is probable that the phagedænic and gangrenous forms, which are usually separated from the rest, are merely the result of the ordinary germs, acting with greater intensity than usual, sometimes for anatomical reasons, more frequently because the vitality of the tissue is greatly impaired, or because there is some other poison (that of syphilis, for example) at work as well. They may be compared to diffuse suppuration; the process of destruction is too rapid for the tissues

to throw out a barrier of granulations, or the poison is so intense that the barrier already thrown out disappears.

As soon as the tissues are able to resist the irritant, the leucocytes cease to melt away as pus, the peptonizing action of the micrococci becomes feebler, coagulable lymph is formed, and new blood-vessels are thrown out. In other words, a layer of vascular granulation-tissue is developed upon the floor of the ulcer, exactly like the limiting fibrin round an abscess; and repair begins at once, as in any other healing wound, by organization and contraction beneath, and organization and the formation of an epithelial layer above.

## GANGRENE.

By *gangrene* or *mortification* is understood the death of a part of the body. A certain size is implied, in distinction from ulceration, in which the destruction is molecular and the tissues melt away imperceptibly; but small patches of gangrene are often present on the floor, or round the edges, of spreading ulcers, and the line between them is ill-defined. The term *sloughing* is used for the soft tissues; *necrosis* for the hard ones—bone and cartilage; and, in the latter case, the dead portion when encased in living bone is known as a *sequestrum*. When not so encased, the dead portion is termed an *exfolium*.

Gangrene is *dry* or *moist* according to the changes the part undergoes. In the dry form the color at first is pale, or dead white with a bluish mottling here and there; the skin is shriveled, and as it were shrunken on the structures beneath; at first, it has a peculiar semi-translucent look; but very soon it loses this, becomes opaque and dark, and then grows more and more black until at length the part becomes hard, dried, and mummified. Putrefaction cannot occur because there is no fluid. In the moist form, on the other hand, decomposition is always present. The part is engorged with blood; the hæmoglobin soaks through and stains the skin, so that it becomes dark and livid; bullæ form on the surface, filled with reddish fluid of a very offensive description; the epidermis is detached; ashy-gray or green patches make their appearance; the part becomes swollen, and crackles under the finger from the formation of putrid gases; and the smell is most offensive.

Which of the two forms occurs depends upon the amount of fluid present.* Dry gangrene, therefore, is chiefly met with in old people, with thin, spare limbs, in whom the arteries supplying the part slowly become blocked with thrombi. Even in them, however, a certain amount of decomposition usually takes place as the line of separation is formed, or when the gangrene involves the calf. In the former case the necessary amount of fluid is supplied by the liquefaction of the plasma under the influence of the pyogenic organisms; in the latter it comes from the tissue itself.

**Causes.**—The causes of gangrene are the same as those of inflammation, physical and mechanical irritants, and infective organisms. The chief difference is that they kill the tissues outright, either directly or by cutting off the blood-supply, instead of merely impairing their vitality.

1. *General.*—These are, for the most part, predisposing only, but sometimes they are so powerful that, as in Raynaud's disease (symmetrical gangrene), it is scarcely possible to find a local one. They include anything that can in any way impair the general health or interfere with the quantity or the quality of the circulating blood. Cardiac disease of all kinds, valvular and degenerative; loss of blood; exhausting illnesses; prolonged fevers; Bright's disease; diabetes; exposure; starvation and intemperance, are some of the most common. The prolonged use of ergot is said to lead to gangrene, but probably only when it is assisted by other causes.

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[* It is easy to see that the condition of the veins and lymphatics must determine the relative moisture or dryness. When the lymph channels or veins, or both, are occluded, or contracted through swelling, then there must be œdema in the part.]

Most of these act upon the tissues directly as well as through the circulation. Whether loss of nerve-power has much influence, except in so far as it impairs nutrition from disuse, is uncertain. There is more evidence in favor of nerve-irritation. That inflammation can be induced in this way is generally admitted; and there are cases on record in which the process has been so severe as to lead to gangrene of the most acute type—sloughing bed-sores for example—within twenty-four hours after an injury. Whether this is due to trophic nerves, or to spasmodic vaso-motor contraction, brought about by reflex irritation, is not known. The existence of the former is not proved; while in favor of the latter is a remarkable case recorded by Hilton, in which the pressure of an exostosis upon the ulnar nerve caused gangrene of the little and adjacent side of the ring-finger, the stimulus conveyed by the sensory fibres to the nerve-centre being reflected down the vaso-motor ones to the vessels, and cutting off the blood-supply.

2. *Local.*—Any kind of irritant can cause gangrene, the degree of severity required being in inverse ratio to the activity of nutrition; a scratch or bruise is sufficient when the vitality of the part is low.

### (*A*) *Physical or Mechanical Irritants.*

Some of these act upon the tissues themselves; others kill them by cutting off the blood-supply. Heat and chemical agents are examples of the former, arterial obstruction of the latter.

Obstruction of an artery may be due to rupture, ligature pressure, thrombosis, embolism, or inflammation. As a rule, the collateral trunks enlarge sufficiently to make up for it; but if the vessel that has given way is a large one, so that there is an enormous extravasation under high pressure; or if the walls of the other vessels are rigid and atheromatous, so that they cannot dilate, the blood-supply is cut off and that part dies. Venous obstruction, owing to the freedom of anastomosis, rarely leads to this; but in strangulation by ligature, or when a piece of intestine is caught in a narrow canal, the veins are compressed first, and the congestion so caused gradually blocks the arteries.

### (*B*) *Organized Irritants.*

These are the same micro-organisms as in inflammation, only they are acting now with greater intensity. In the one case they lower the vitality of the tissues, in the other they destroy it. They differ from physical and mechanical irritants in the fact that their action is continuous; they spread wider and wider, invading the tissues farther and farther, until either their energy is spent or they meet with some part sufficiently well-nourished to resist.

Of these some are certainly specific (anthrax, malignant pustule, glanders, and possibly a few more). Others which, like these, invade living structures, do not give rise to specific diseases, but merely to inflammation of great severity. They impair the vitality of the tissues to such an extent that they slough. This is the case with spreading traumatic gangrene and hospital gangrene: no specific germ has been proved to exist in them; they are merely the result of the ordinary organisms of suppuration acting under peculiarly favorable conditions. Whether noma, cancrum oris, and phagedæna should be included is still a matter for question. Carbuncles and boils are undoubtedly due to ordinary micrococci.

This form of gangrene is always moist; putrefaction is present, as well, wherever the slough is exposed to the air; and the products bathing the surface of the sore, lowering the strength of the patient as well as the vitality of the tissues, materially assist the progress of the original cause.

### *Subsequent Course.*

As soon as a part of the body has been killed, whether by mechanical, physical, or organized irritants, an attempt is made to get rid of it. The success

which attends this depends upon three conditions: the nutrition of the tissues, the persistence of the original irritant, and the presence or not of any other in addition.

1. *Where the tissues are healthy, where the injury is not repeated,* and where no other irritant is allowed to intervene, the dead portion is either absorbed or thrown off, according to its position.

If it is in the interior of the body it simply undergoes degeneration and is tranquilly removed. A portion of tissue that is dead acts as a very slight irritant on the structures around. The pedicle of an ovarian tumor that has been ligatured and returned into the abdominal cavity is an instance; the neighboring tissues become more vascular, leucocytes and plasma pour out in greater amount, the strangulated part gradually becomes invaded by them, new vessels are formed and extend farther and farther into its substance, and at length it completely disappears. In the same way a bony sequestrum of small size, and even dead substances of an entirely foreign nature, such as ivory pegs, can be removed.

If it is in the skin, under the same conditions, the same changes occur round the buried part, but the exterior dries up and becomes hard and dense. Absorption, accordingly, is impossible, except to a very slight extent; the lymph that is thrown out by the living tissues becomes organized; the deep part is converted into fibrous tissue; the superficial, where it is in contact with dead material, is covered over with epidermis, which grows in from the margin, and at length the dried-up mass drops off by itself, leaving a perfectly healed surface beneath. A burn, for example, covered up at once, may remain dry, and form a scab under which repair is completed without the least further loss of tissue or suppuration. The line along which the separation takes place is known as the *line of demarcation;* on the one side is the dried-up dead material, on the other the living tissues, reddened, slightly swollen, and more tender than usual, because, owing to the presence of an injury, there is more than the ordinary degree of repair required, and the circulation is quicker and more active.

It must be acknowledged that suppuration is rarely absent when the gangrene is of considerable size; but it is an accident and not essential. The slough, if the adjacent tissues are healthy and uninjured, can be detached without the loss of a single leucocyte.

2. *Where the vitality of the structures near is impaired, but not very seriously.* At once this gives a foothold to pyogenic micrococci, which are always at hand and ready; suppuration takes place, and, although the gangrene does not spread, the loss of tissue is greater than is accounted for by the slough alone.

(*a*) The general nutrition may be enfeebled from any of the causes already mentioned. A burn, which, in a healthy child, would heal without suppuration, may give rise to extensive ulceration in a person suffering from Bright's disease or diabetes.

(*b*) The local nutrition may be impaired, owing to the surrounding parts having been affected by the original injury. In frostbite, for example, part of the tissue is killed outright, but the vitality of the structures for long distances round is so enfeebled that they are unable to resist the onset of the micro-organisms. The same thing occurs in bad crushes and bruises; large subcutaneous extravasations of blood are very prone to suppurate, partly because of the tension, but partly also because the tissues round are injured and unable to hold their own.

(*c*) Other irritants may make their appearance and help to weaken the resistance of the still living tissues. These may be of the same nature as the original one, or different. Tension, for example, prevents a slough being detached without suppuration. Friction and want of rest do the same. Septic decomposition is still more powerful, the ptomaïnes it produces causing the death of the structures they touch to a depth that depends upon the activity of their nutrition. If healthy granulation-tissue has already been formed, the surface cells merely melt away; but if the part is badly nourished and its vitality depressed, either from constitutional causes or from the original injury, or if the poison can soak into

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is capable of successful resistance.

### Special Forms of Gangrene.

Some of these are due to the action of infective organisms, others are not; but as the one nearly always complicates the other, it is not advisable to consider them apart.

1. Dry Gangrene.—The most typical example is that caused by *thrombosis* in atheromatous arteries, commonly known as *senile*.

It always begins in the lower extremities and can generally be traced to some trivial injury. For some time past the feet and legs have been peculiarly cold and numb; there has been a constant sense of itching and formication; cramp has been very painful in the calf; then suddenly a dark-red or purple spot, surrounded by a dusky ring, is noticed, usually on the inner side of the great toe; and on examination it is found that the action of the heart is very feeble, that the tibial pulse can scarcely be felt, and that the arteries are rigid and hard. As a rule it is the seat of a constant burning pain, but sometimes this is not noticed. Gradually the central patch becomes darker, and encroaches on the areola around; this, without growing wider or narrower, slowly spreads farther and farther; the toe becomes shrunken, dried, and hard; and at length the foot is involved. Progress is rarely uniform; one toe after another may be attacked at intervals. Just below the ankle there is always a rest, sometimes a permanent one; but the tendency is for the disease to progress, sometimes slowly, sometimes quickly, until exhaustion, with extreme depression and low wandering delirium, sets in. *Post mortem* the arteries are usually calcareous, rough, and irregular on the inner surface, and blocked or narrowed by coagula, often as high as the popliteal.

Arterial *embolism* usually gives rise to the same form when it causes gangrene, but, as a rule, the collateral circulation enlarges sufficiently to prevent it. Exceptionally, either because several trunks are plugged at the same time, or the condition of the vessels round is such that they cannot dilate, the blood-supply is altogether cut off. It frequently occurs after endocarditis. The onset is sudden: there is a severe attack of pain in the course of an artery, generally where it bifurcates or gives off one or more large branches: the part feels dead or numb, the temperature falls, the pulse below disappears, and then by degrees the skin passes through the same changes. Suppuration usually occurs while the dead part is being detached, because the living tissues next to it are too much injured to resist the action of the pyogenic micrococci. A certain amount of decomposition may be present, too, after this has taken place and supplied the necessary fluid, but so long as the general nutrition is good, there is little or no fever, and the death of the tissues is, except for the suppuration, limited to the original area.

*Symmetrical gangrene* (Raynaud's disease) is very similar to this in its local changes; but no lesion of any kind—embolism, thrombosis, or degeneration—has been found to account for it. Possibly it is due to arterial spasm arising from cold, and rendered persistent by a hyper-sensitive condition of the vaso-motor centres. It is usually met with in young anæmic subjects suffering from feeble circulation, and always attacks the extremities. In its slighter forms, cold, grayish-blue, ill-defined patches of local syncope or local asphyxia suddenly make their appearance after some trivial exposure, upon the hands or feet, or upon the pinna, very often symmetrically. After a time these may disappear, but occasionally the color remains pale or livid, then turns blue and purple, and finally becomes black. In some instances it is associated with hæmatinuria.

Gangrene due to the direct effect of intense cold presents the same features (*frostbite*). The part is frozen through; the skin remains firm and white, and then passes through the same changes. This, of course, like all other forms, is more likely to occur when other causes, such as old age, starvation, fatigue, or exhaustion, exist; and moist cold is certainly worse than dry. It rarely happens, however, in England that the temperature falls sufficiently for this. Usually, frostbite is caused by the too early application of warmth to a half-frozen surface, and the gangrene is moist. Slighter degrees of cold merely lead to vesication,

like heat, or superficial gangrene; and the slightest, to an erythematous state in which the skin is deep red or livid, and subsequently, when warm, becomes painful and slightly swollen.

Dry gangrene may also be caused by intense heat—the actual cautery, for example; but, as a rule, in cases of burning, the tissues for long distances round are injured to such an extent that inflammation and suppuration follow. Potassa fusa, applied as it used to be when it was desired to form an issue, produces the same result—a limited, shriveled patch of blackened tissue, unable to undergo decomposition owing to the absence of fluid, and surrounded by a zone of suppuration.

A very rare form of arterial obstruction, due to *endarteritis obliterans*, sometimes leads to the same result. I have known it occur in the vessels of the upper extremity, so that when amputation of the arm was performed, the brachial did not require ligature. The symptoms resemble those of steadily advancing thrombosis, attended with severe pain. Most of the cases have occurred after middle life, without any very obvious reason.

All these forms of gangrene resemble each other in being practically unattended by decomposition. A portion of tissue is killed, either by being entirely deprived of blood, or by the action of some external agent. It acts as a foreign body, almost inert, so long as no other irritant is allowed to appear. The surrounding tissues are uninjured, and at once, if their nutrition is sufficiently good, commence the process of repair. Unhappily, in the senile form due to thrombosis (the most typical and the most common of them all), it usually happens that the clot extends farther and farther up the artery, so that successive portions of the limb become involved and perish; and in any case the vitality of the part is very feeble. In other instances the blood-vessels round the injured area dilate; lymph pours out through their walls, new vessels are developed, and, by degrees, a layer of vascular granulation-tissue (forming the so-called line of demarcation) is developed round the whole of the buried surface of the necrosed tissue. If this is small and completely surrounded, it may be absorbed and disappear entirely; if it lies on the surface it gradually dries up, and is thrown off by the granulations beneath.

Suppuration is not necessary for this process, although, unless the necrosed fragment is of very small size, it is nearly always present. The pyogenic organisms gain access either through the air or through the blood-vessels or lymphatics. The plasma no longer coagulates, the leucocytes near the infected spot perish and form pus-corpuscles, and the walls of the vessels and the tissue, already organized, undergo coagulation-necrosis and melt away in the fluid.

2. MOIST GANGRENE.—This may commence as such, or it may be dry at first. Senile gangrene, for example, is very often dry until the calf is reached; then, owing to the greater amount of fluid, decomposition sets in.

Dry gangrene does not extend unless the original cause is repeated—unless, for example, the thrombus spreads higher up the artery. Moist gangrene, on the other hand, whatever the cause, spreads until it meets some structure sufficiently well-nourished to hold its own. The products of putrefaction, soaking into the living tissues near, lower their power of resistance, and if their nutrition is impaired in the least degree, or if the irritant is assisted by tension, want of rest, or any other cause, they must give way. If the conditions are exceedingly unfavorable, the surrounding tissues perish *en masse* (sloughing phagedæna and hospital gangrene); if not quite so bad, if their vitality is merely impaired instead of being destroyed, they become inflamed, and as pyogenic organisms are always present in such circumstances, melt away as pus.

Whether specific micro-organisms are present in many of these cases, as well as septic and pyogenic ones, is uncertain, and the difficulty is especially great in connection with such diseases as cancrum oris and phagedæna. None, however, has yet been proved, and in the absence of this, it is more reasonable to assume that these diseases, attended with very characteristic and extensive destruction,

are the result of the ordinary germs, acting under conditions peculiarly favorable to them: overcrowding, for instance, and poisoning by foul air, in the case of hospital gangrene; and syphilis in the case of phagedæna.

The simplest example of moist gangrene is seen in a lacerated wound. A portion of the tissue is killed, it remains for two or three days adherent to the surface, slowly changing color, and then quietly drops off, detached from the part that is living by the vascular lymph thrown out. If it is very tough and hard—tendon, for example, or bone—so that the blood-vessels are scanty and unable to dilate, the process may take weeks instead of days.

Bed-sores, due partly to pressure, partly to the irritation of urine and retained perspiration, are examples on a larger scale. The skin at first is reddened, then fluid collects beneath the epidermis; this gives way, exposing the corium; and the continued irritation and pressure combined soon cause it to slough. Decomposition sets in, and the poison so formed, added to the already existing causes, kills the tissues round until a part is reached where the vitality and power of resistance are sufficiently good.

Nearly all forms of gangrene that are dry at first end in this way. Even if the centre remains hard and resists putrefaction, suppuration occurs around the margin, and the pus provides a sufficient amount of fluid for putrefaction. Fortunately, as a rule, by the time this has happened the tissues around the slough have recovered themselves, and have erected a barrier of young and vascular granulation-tissue, which may lose its surface as pus, but nothing deeper.

When a limb is run over and crushed, or when a large artery gives way subcutaneously and cuts off the circulation by the pressure it causes (*local traumatic gangrene*), the changes are the same at first. Immediately after the accident the limb is cold and loses its sensibility, the skin is even whiter than natural, and is stretched and tense from the extravasation beneath, and the pulse cannot be felt. Then the color gradually becomes dusky and livid, especially toward the lower part, to which the blood gravitates; purple and green patches make their appearance; bullæ form, filled with a reddish fluid; the epidermis is detached from the corium beneath; emphysematous crackling can be felt here and there, and the odor is most offensive.

The subsequent course, whether the gangrene remains local or begins to spread, depends upon the power of resistance of the tissues that are still living, to the combined irritants. If the size of the slough is small, the tension low, and the condition of nutrition good, the tissues soon protect themselves, and a line of demarcation gradually forms. If, on the other hand, the part involved is large, such as a limb, and the tension in it is high, the products of decomposition, unable to escape, spread into all the cellular spaces in the living structures near, and stream into the lymphatics, poisoning everything they touch, and causing intense inflammation. The local traumatic gangrene, assisted by decomposition, has begun to spread.

The worst example of *spreading traumatic gangrene* met with at the present day is that which sometimes occurs after compound (open) fractures, especially those due to direct violence. There is everything to favor its occurrence and its extension; an enormous extravasation at a high temperature; a wound, so that decomposition can begin at once; the opening usually valvular, so that the tension from the hyperæmia that follows must be high; fractured, and often dead, bone, which in some particular way is exceedingly favorable to decomposition; and all the cellular spaces in the tissues round widely open still, with no protecting barrier of lymph. Under conditions such as these it is no wonder that, if septic decomposition occurs, and the products are not allowed to escape, spreading traumatic gangrene of the worst description follows. The part swells more and more; the skin is tense, red, and burning hot; the loose cellular tissue on the inner side of the limb and along the great vessels is boggy and œdematous, filled with a sero-purulent fluid which rapidly decomposes and causes emphysematous crackling; the redness keeps spreading farther and farther, round the seat of injury it gradually

becomes dull and livid, then the cuticle separates, the tissue becomes soft, and, if the patient live sufficiently long, the whole part decomposes.

As described above, if the vitality is already depressed from other causes, constitutional or local (Bright's disease, for example, or cold), spreading traumatic gangrene will follow even when the irritant is comparatively slight.

Local traumatic gangrene, unless the part is exceedingly small and the escape absolutely free, is always attended with fever. Even when there is only a lacerated wound with a few shreds hanging from it, there is some absorption, which diminishes as the tissues become by degrees able to protect themselves. In the spreading form, setting in at once, before the cellular spaces, are closed, with an immense amount of poison and very high tension, the absorption is naturally excessive, and the constitutional disturbance may prove fatal in the first few days. In some cases the temperature rapidly runs up to 104° or 105° F.; the pulse is full and quick, and the respiration hurried and rapid. In others, and they are usually the worst, it scarcely rises at all, the pulse is small and feeble, the patient is delirious, the face is dusky, the tongue dry and brown, and the symptoms are typhoid from the beginning. If the patient survives the period of spreading gangrene, and the tissues gain the upper hand, resisting the further advance of the irritant, and throwing out a wall of vascular lymph, the fever begins to fall, especially of a morning, and assumes the remittent type, characteristic of suppuration without free exit for the pus.

Given local traumatic gangrene—a part of the body, that is to say, killed by injury of any kind—the consequences, whether a line of demarcation forms, or inflammation and suppuration set in, or spreading gangrene follows, depend upon the vigor of resistance offered by the tissues, and the degree to which they are protected from other irritants. If they are healthy constitutionally, and were not injured when the neighboring part was killed, and are not injured by any other agent (tension, want of rest, or decomposition), lymph is thrown out, and repair is commenced at once. If they fail to a slight extent in one or more of these conditions—if, that is to say, their vitality is lowered—inflammation sets in and spreads until a healthier part, capable of better resistance, is reached. If they fail seriously—if their vitality is destroyed—the gangrene spreads.

**Treatment.**—The general principles are the same in all forms, but special measures have to be adopted in the case of some of them.

1. *Constitutional.*—The reis always well-marked general depression; very often it is one of the predisposing causes, weakening the tissues and rendering them more susceptible to the action of injurious agents, and if not already present it always makes its appearance in the course of the disease. Everything, therefore, must be done to husband and maintain the general strength; food must be nutritious but easily assimilated, and given, therefore, in small quantities at frequent intervals. Stimulants are required to assist digestion, or, if the heart is weak and the pulse feeble, to maintain the circulation. Opium may be given to relieve pain and procure sleep. Fresh air is absolutely necessary, particularly if decomposition is going on, and special attention must be paid to any constitutional disorder that may be present, such as Bright's disease or diabetes. Very great care, however, is required in the matter of food, especially in the case of old people. It often happens that for years past they have taken it in exceedingly small quantities, their strength being economized to the utmost by rest and warmth, and any attempt to increase it only defeats its own end. Under these conditions it is not uncommon to find that comparatively large quantities of stimulants, especially brandy, are very well borne; and, provided the surrounding temperature is carefully maintained, enable the patient to tide over the crisis.

2. *Local.* (i) *Preventive.*—Sometimes when the onset is gradual the cause of the gangrene can be removed in time. The constriction may be divided, for example, in the case of a strangulated hernia or paraphimosis; the tension relieved by timely incision in phlegmonous erysipelas or cellulitis, and the pressure in bed-sores distributed over a wider area, or transposed to another part of

the body altogether. In many cases, however—especially those in which the blood-supply is cut off—any measure of this kind must be too late.

(ii) Where this cannot be done, an attempt must be made to stay the progress of the disease by preventing the repetition of the original cause and the access of any other.

The circulation must be assisted in every possible way. The part should be raised, so that veins and lymphatics can empty themselves with ease; the temperature kept perfectly even, and absolute rest enforced. Nothing answers so well as investing the whole limb in cotton-wool, which may be impregnated with some antiseptic to assist in checking decomposition; poultices should always be avoided, and wet fomentations, which, by the moisture they contain, encourage the softening of the epidermis. In some cases of senile gangrene, in which there is no surrounding inflammation, and the skin of the limb is not tender, gentle upward friction is of service, as it tends to empty the veins and increase the flow through the neighboring tissues.

The least tension in any part must be relieved at once. Free incisions are often required, not only to reduce the pressure upon the skin, and prevent it sloughing, but, by giving exit to pent-up fluids, to check absorption and allow the blood to circulate more freely. The wide gaping of the cuts, the continued draining from their edges not only of blood, but of inflammatory exudation, and the wrinkling of the skin on the following day, afford a very good explanation of the fall in the temperature and the diminution in the fever that always follow.

[Application of external heat, by means of hot-water bags, will be found useful, not only in treatment, but as one of the aids to prevention.]

Decomposition must be prevented. This may be accomplished in various ways. In many forms of local traumatic gangrene—where, for example, the fingers have been crushed, and it is not known how much is hopeless—prolonged warm and antiseptic baths are most beneficial. If the part is only small, corrosive sublimate (one part in ten thousand) may be used for several hours a day at first, and then, when the putrefactive odor is overcome, for an hour night and morning. If the part is too large, so that absorption is feared, or if the patient complains of pain, boracic acid may be substituted, but it is not so efficacious. The injured part is dependent, it is true, especially when the lower extremity is concerned, but this disadvantage is fully compensated for by the relaxation of all the tense and inflamed tissues, by the regularity of the temperature, the free escape for the inflammatory exudation, and the impossibility of decomposition.

When, on the other hand, the gangrene has a tendency to become dry, absorbent dressings and iodoform should be used. Salicylic wool, wood-wool impregnated with corrosive sublimate, moss treated in the same way—anything, in short, that checks putrefaction—succeeds in proportion to its power of absorption. The dressing, however, unless the gangrene is of the driest type, needs changing frequently, for fear that a solid mass of dried discharge may form like a scab over the ulcerating surface and keep the fluid beneath pent up. At the same time tension should be relieved by suitable measures, gentle compression, elevation, and even incision, and sloughs or portions of dead tissues removed as soon as they are loose. The greatest care must be taken, of course, not to injure or irritate in any way the protecting barrier of granulations: this has been formed by tissues that are only just able to hold their own, and no more; and the least damage done to them at once causes the sloughing to spread; but this is no reason why parts which are clearly dead, and which can be removed without injury to those around, should not be taken away as soon as they can.

As the line of demarcation forms and gradually grows deeper and more defined, the sloughs of the soft parts usually separate of themselves, until at length the bone is left with—hanging around it—tendons and dense sheets of fascia, which, owing to the anatomical condition of the circulation, are only detached after prolonged suppuration. Sometimes when this is the case the soft parts may be very gently retracted, lateral incisions being made to give more room, and the

projecting structures carefully divided; otherwise the natural process of separation may take an immense length of time; but this should not be attempted until the spreading of the gangrene is no longer feared.

(iii) *Amputation.*—In local traumatic gangrene—such, for example, as results from the rupture of a large artery, with or without fracture—amputation should be performed at once, sufficiently far above the seat of injury to secure healthy flaps. It means that the attempt made to save the limb has failed; and if gangrene begins, it is certain to spread as high as the seat of injury, and very likely not stop there. Nothing, therefore, is gained by waiting.

In spreading traumatic gangrene the conditions are different. If it is due mainly, or even in part, to constitutional causes, amputation higher up would be followed by the same consequences. In some very rare cases, however, it is purely local, due to the presence of a poison retained under high tension, usually decomposing, extravasated blood; and then it is just possible that amputation higher up, performed sufficiently early, would succeed; but in such cases as good a result may be obtained by free incision, relieving the tension and checking absorption.

In no other case should amputation be performed until the line of demarcation is well established; and even then, in the majority, it is wiser to wait until all the soft parts have separated and the wound so left is beginning to cicatrize. Excision of the projecting end of the bone, even with a certain amount of soft tissues round it, is a very much less serious operation than a formally planned amputation; and, unless the patient is being exhausted by suppuration, is always to be preferred. Owing to the conical shape of the stump left by gangrene something of this kind is always required.

[It is the danger of the production of septicæmia that causes us to override this injunction frequently. The carrying into the circulation of highly infectious material is so dangerous to the patient, that early amputation must be done in many cases.]

Special Forms of Gangrene.—*Senile Gangrene.*—Nutritious, digestible food, with a reasonable supply of stimulants; rest, elevation, and equable warmth, are here the most important measures. The part should be well sprinkled with iodoform, and then covered up thickly with many layers of cotton-wool. Care must be taken never to keep it exposed for any length of time, and not to allow hot water bottles too near. Poultices should not be applied under any circumstances. In this form of gangrene, in particular, opium is of the greatest value, and it has been said that recovery or not may be foretold from the way in which the patient stands its administration.

Hutchinson has recently advocated high amputation (through the lower third of the thigh) in both the dry and the inflammatory form of senile gangrene: the limb is usually small and wasted at that point; the artery is sound in Hunter's canal; the flaps are well supplied with blood; and old people, as a rule, resent operation very slightly; their tissues are not prone to inflammation. The alternative is to let the part alone, confining the patient practically to one position in bed, until a line of demarcation has formed, leaving a very conical stump, which does not heal of itself, and which does not admit of being interfered with. Probably, in many cases, in spite of the apparent severity of the operation, such a measure is really advisable, not, of course, if the gangrene is limited to the toes, or even to the front part of the foot, but if it extends to, or in the least degree above, the ankle. If it spreads to the calf, even the driest form is exceedingly liable to become moist, and then the inflammation nearly always proves fatal.

In frostbite the greatest care must be taken not to warm the part too soon: if it is exposed even to a moderate temperature before the circulation has recovered, moist gangrene is almost sure to follow. Amputation should never be performed until the line of demarcation is deeply cut.

In that form which is due to embolism the same rule practically holds good, although an operation may be performed somewhat sooner; the surrounding tissues

are not so badly injured. The constitutional disturbance, however, in these cases is very rarely severe, and the risk of septic absorption very slight.

## PHAGEDÆNA.

Phagedæna is an exceedingly rapid form of molecular disintegration or ulceration, chiefly met with at the present day in connection with syphilis. There is, in the ordinary variety, no sloughing, swelling, œdema, or extensive redness; simply the base and the edges of the ulcer affected by it become liquid and melt away. In another variety, however, which is much more rare, sloughing is present as well, the surrounding tissues becoming swollen, tense, and hard, and then gradually turning black. No specific organism has ever been proved to exist, and it seems more reasonable to assume that the ulceration becomes phagedænic because of certain predisposing causes, of which syphilis is a very important one. Exposure to cold and wet, privation, and extreme youth are probably not without influence. In the vast majority of cases primary syphilitic sores that become phagedænic (sixteen out of seventeen, according to my notes on the subject) are followed by secondary syphilitic symptoms.

Constitutional treatment is of very great importance. Phagedæna may arise in connection with syphilis in people who are apparently strong and otherwise healthy; but it is much more frequent in those who are broken down from long-continued exposure and intemperance.

When it is practicable, nothing succeeds so well as prolonged warm baths and iodoform; the former during the daytime, for from eight to ten hours, the latter dusted on at night. The ulceration nearly always ceases to spread at once, and the sore begins to throw out granulations. If this cannot be done iodoform may be used alone, or if the sore is in such a position—on the ala of the nose, for example—that it is absolutely necessary to stop the extension at once, the patient should be placed under an anæsthetic and the acid nitrate of mercury applied freely. The pain, which lasts for twenty-four hours, may be controlled to some extent by using a lotion of cocaine, renewing it frequently. Unless the existence of syphilis can be definitely excluded, a mild mercurial course (Hyd. c., cret. gr. ij, gm. 12, with Dover's powder night and morning) should be commenced without delay.

## HOSPITAL GANGRENE.

Hospital gangrene bears the same relation to ordinary traumatic gangrene that phagedæna does to ulceration; sometimes it is known as sloughing phagedæna. It is a form of gangrene which breaks out under certain conditions that used to be of frequent occurrence in connection with hospitals, and attacks every kind of wound, small as well as large. It spreads with the greatest rapidity and is intensely contagious. The surface of the wound is covered with micrococci, which extend deeply into the substance of the tissues, destroying them wherever they come in contact with them. Whether they are the ordinary forms of staphylococcus and streptococcus working under peculiarly favorable conditions, or whether they are specific, is not known; the former view is the more probable, as hospital gangrene never occurs except under certain conditions, and apparently never fails to be produced by them. Overcrowding and absence of ventilation will cause it anywhere; probably the intensely poisonous substances produced in these circumstances, soaking gradually into the tissues for days and weeks together, impair their vitality to such an extent that the ordinary germs are able to act with the most unusual energy and produce the most disastrous results. The general nutrition is in the same condition as that of the case already mentioned, in which gangrene of both legs followed after primary amputation of the feet, only the cause is a different one.

[The treatment of hospital gangrene requires the careful removal of the

sloughing parts with the forceps and scissors, and the application of bromine solution as strong as may be necessary.]

In connection with this, it is noteworthy that sloughing cellulitis of the most intense description occurs in some cases of snake-bite, and in some forms of post-mortem poisoning, and, what is very significant, not always in the neighborhood of the wound. In the former of these at least it is practically certain that the gangrene is due to the virulence of an alkaloid, which, though it is not sufficient to kill the tissues at once, lowers their vitality to such an extent that they fall an easy prey to the micro-organisms that enter from time to time into the blood. In the latter—when, for example, all the cellular tissue on the side of the thorax becomes gangrenous forty-eight hours after a punctured wound of the finger—the same explanation is highly probable; and it does not seem unlikely that hospital gangrene is really due to saturation of the blood with the scarcely less virulent poison thrown off by the lungs in cases of overcrowding.

## PHLEGMONOUS INFLAMMATION.

Diffuse inflammation of the cellular tissue and skin, the so-called phlegmonous erysipelas, is another product of the ordinary micrococci of suppuration acting under peculiarly favorable circumstances. In many respects it resembles true erysipelas, especially in the conditions under which it occurs, but in its nature it is essentially different. Like erysipelas, it usually spreads from a wound; those who are broken down in health from intemperance, exposure, and particularly Bright's disease, are much more prone to it than others; and in a very large proportion of cases a streptococcus is found in connection with it. But, on the other hand, it is not infectious, although it is in the highest degree contagious; it always ends in suppuration and sloughing; it may follow injuries of the most varied description—post-mortem wounds, bites of reptiles, or the sting of a wasp; it attacks deep-seated parts of the body, such as the pelvic cellular tissue, after parturition or lithotomy; and it is never accompanied by the characteristic, well-defined rash always present in true erysipelas. The affection of the skin is an altogether secondary complication, which may or may not be present, according to the original seat of inflammation. Further, the streptococcus, which is undoubtedly the ordinary S. pyogenes, is not confined to the lymphatics, as in the case of the S. erysipelatis, but migrates freely beyond into the cellular spaces, and penetrates through the adventitia of the vessels into their interior.

**Causes.**—In some rare cases diffuse inflammation originates without a wound. Nearly always, however, an injury of this kind is present, opening up the submucous or the subcutaneous cellular tissue, or the deeper planes among the muscles or round the bones. When there is none, the germs—as in acute infective osteomyelitis—gain access to the part through the blood. Occasionally the inflammation commences some little distance from the seat of infection; and exceptionally it does not attain any great degree of severity until this is healed.

The predisposing conditions are general and local. The former are those already mentioned in connection with gangrene—diabetes, Bright's disease, the consequences of exposure, intemperance, starvation, and, briefly, everything that tends to interfere with the elimination of waste product or impair the general nutrition. Overcrowding and bad ventilation are very important in this respect; probably their influence is due to the poisonous substances exhaled from the lungs, which, even when breathed for a short time, produce the most extreme depression.

The local conditions are very simple: imperfect drainage, especially if there is a cavity filled with extravasated blood, is sure to cause it. It is for this reason that diffuse inflammation of the most disastrous character is so common after compound fractures or penetrating wounds of joints. Decomposition occurs under high tension before the tissues are able to protect themselves in the least, and the products are driven into the loose cellular interspaces, poisoning and destroying

everything they touch. For the same reason the condition of the uterus after parturition, with an enormous development of cellular and lymphatic tissue in the region of the cervix, renders it particularly susceptible.

Bruising and tearing the structures round in performing an operation—in other words, lowering their vitality and filling them with extravasated blood—greatly increases the liability to it. It is partly owing to this, partly to the effect of renal disease, that diffuse inflammation of the pelvic cellular tissue is so common and so fatal after lithotomy when the calculus is a large one. In other cases it is due to the local effects of virulent chemical poisons. Diffuse cellulitis of the neck, for example, may result from the sting of a wasp, and sloughing over a very large surface has been known to follow the bite of a poisonous snake. Probably the alkaloid injected into the tissues lowers their vitality to such an extent that they are unable to offer any resistance to the micrococci, which are constantly finding their way into the blood. Whether the extremely fatal form of diffuse cellulitis which accompanies post-mortem wounds in cases of puerperal peritonitis is due to a similar alkaloid, or whether, on the other hand, it is the result of septic infection (infection, that is to say, with a living organism) is uncertain. The fact that the virulence of the poison diminishes rapidly as putrefaction sets in is consistent with either view; the exceedingly early occurrence of the symptoms favors the former.

**Symptoms.** 1. *Constitutional.*—These vary greatly in severity. In the worst forms, such as those arising from post-mortem wounds, they are practically the same as in spreading traumatic gangrene. They assume a typhoid character almost from the first; there may be a rigor or a succession of chills: the temperature rises rapidly to 105° or 106° F.; the tongue is dry and brown, the skin burning hot, the face dusky, and the pulse so small and quick that it is scarcely possible to count it. Delirium may set in, sometimes with profuse sweating, within twenty-four hours, and the result may be fatal, from the most acute form of septic poisoning, within the first few days.

In pelvic cellulitis after parturition or lithotomy, the effect is almost as rapid, the patient sinking into a semi-unconscious, wandering state, with an irregular, feeble pulse, extremely high temperature, and the most profound nervous prostration. When the cellular tissue of the limb is concerned, where the poison is not so intense or the absorption so rapid, the symptoms are less severe, and usually assume the sthenic form, but the fever continues high and very irregular for days and weeks; the emaciation and exhaustion are extreme; there is always the danger of pneumonia and pleurisy, or, if the head or face is involved (particularly the orbit), of suppurative meningitis; and if the patient survives the period of sloughing and acute absorption, pyæmia not uncommonly supervenes or hectic and diarrhœa follow, or the prostration is so great that some comparatively slight disorder sets in and proves fatal.

2. *Local.*—These naturally vary with the structure of the part, but the swelling is always very great, soft and œdematous at first, then becoming hard and brawny, and later, as the cellular tissue sloughs, softening again and becoming boggy. On the scalp it is usually due to wounds that open up the sub-aponeurotic layers; the œdema spreads rapidly over the vertex, extending down to the eyelids in front, to the superior curved line or the occipital bone behind, and the zygoma on either side. The skin is exceedingly tender, but there is very little redness; the glands in the neck are enlarged and swollen, and there is always intense headache and not unfrequently delirium. When it involves the orbit, the eyelids are immensely swollen, the conjunctiva is reddened and chemosed, the globe is pushed forward and fixed, and the pain is most intense. If the symptoms do not soon subside, the cornea becomes opaque and sloughs, the eyeball is completely disorganized, and there is very great danger of the inflammation extending along the veins or lymphatics to the sinuses of the cranium or the meninges, leading to thrombotic pyæmia or acute meningitis.

**Diffuse inflammation** of the cellular tissue of the neck is no less serious.

Usually it commences in the submaxillary region, caused, in all probability, by the absorption of some poison from the mouth. The swelling extends rapidly downward, beneath the deep cervical fascia, giving rise to the most intense pain, with violent constitutional disturbance, and pressing upon the veins and the trachea. Sometimes, even, it reaches to the mediastinum and involves the pleura or pericardium. The skin is white and tense, the swelling exceedingly hard and very painful, and any movement is impossible.

In acute pelvic cellulitis the local symptoms resemble those of peritonitis, in which it often ends, except that the boundaries of the swelling are generally more defined. In the more chronic cases the uterus is fixed, and a hard mass is left projecting above the brim of the pelvis when deep pressure is made in the iliac fossa. If suppuration follows, the abscess may point in the iliac region above Poupart's ligament, or it may present in Douglas's pouch, or extend into the thigh, or the psoas muscle, or reach even as high as the kidney.

In the case of the limbs, diffuse inflammation nearly always originates from a poisoned wound, a punctured wound of a joint, or a compound fracture. Occasionally it occurs in connection with acute suppurative periostitis. When the deeper planes are involved, the skin is tense, white, and œdematous, but burning hot to the touch and exceedingly tender. Very often it is mottled with dusky red patches, which correspond to the places of communication with the deep veins. The pain is extreme, of a tense, throbbing character, and movement is out of the question. Usually the inflammation extends higher up the inner side of the limb than the outer, very often following the course of the large vessels; and the neighboring lymphatic glands are always enlarged and tender. When the part affected is the subcutaneous layer, the symptoms are for the most part the same, but the color is a deep, dusky red, shading off imperceptibly, not, as in erysipelas, with a sharply-defined margin. At first the skin is soft and pits on pressure; then it becomes hard and brawny; vesicles and blebs form upon the surface; the color grows deeper and deeper, in one or two places it becomes almost purple, and then, here and there, it softens and becomes boggy to the touch. In other words, the subcutaneous cellular tissue has passed through the stages of extreme hyperæmia and exudation, and has sloughed; in some places, if it is cut into, it is soft and gelatinous, distended with a sero-purulent fluid, which can be squeezed out of it like water from a sponge; in others it has practically disappeared, and nothing is left but a sheet of pus, without any definite limits, mixed with the shreds and sloughs of the fasciæ and the tougher parts of the connective tissue. Later still, if no incisions are made, the skin itself perishes, cut off from all source of nutrition except where some of the larger vessels enter it from the inter-muscular septa beneath; here, in general, a few islets still persist in the middle of the destruction. In the worst cases, in which nothing has been done to relieve the tension, the fasciæ and muscles are bared and dissected away from each other, the joints are opened, the bones exposed, and the limb is reduced to a perfectly hopeless condition.

**Prognosis.**—The prognosis in the case of diffuse inflammation of the cellular tissue is always exceedingly grave. If the head is involved, portions of the scalp may slough, the pericranium may perish, and osteophlebitis, pyæmia, or meningitis follow. In the case of the orbit the danger is even greater, and at best the eye is almost sure to be destroyed. The inflammation may spread from the cellular tissue of the neck to the pleura or pericardium, or it may prove fatal from extending to the larynx. After lithotomy it is practically hopeless. Even when one of the limbs only is concerned the danger is very great. Osteophlebitis, lymphangitis, or pyæmia may follow at any time. The inflammation may spread to the neighboring joints and lead to acute suppurative arthritis. The bones may necrose, the great vessels may be injured, and even when all these more serious consequences are escaped, the limb may be rendered useless and become a constant source of pain from the sloughing of the subcutaneous and inter-muscular cellular tissue. The wounds heal slowly; the cicatrices are adherent to the muscles or the

bones, so that they are constantly breaking down; the lymphatics are destroyed; solid œdema sets in; and, even after the most successful treatment, the part is left stiffened, cold, congested, and practically useless for active movement for months and even for life.

**Treatment.**—In the most acute form of diffuse inflammation the prostration is so extreme and the heart fails so rapidly that very little can be done. Stimulants—ammonia, ether, and brandy—must be given freely as long as the patient can absorb them. Sometimes, when the constitution is otherwise healthy, and the effect is due to the local absorption of a chemical poison, it is possible to tide over the crisis, and under these circumstances enormous quantities may be given with very great benefit; but this is of no avail if the production of the poison continues. In cases that are less severe, in which the immediate danger is not so great, careful watch must be kept upon the pulse, and everything must be done to support the patient's strength. It must always be remembered that, unless it is the result of some very grave injury, diffuse inflammation rarely occurs except in those whose constitutions are thoroughly broken down, whose strength is exhausted, and who have been accustomed to the free use of stimulants for years past; but, if possible, remedies of this kind should never be given alone, always in small quantities at a time, with beef-essence, milk, eggs beaten up, and other foods that possess a more lasting value.

The local treatment is no less important. Everything must be done to check absorption from the surface of the wound and diminish the tension. Cold is of less value in these cases than in other forms of inflammation. The vitality of the part is already very feeble, and there is some danger of causing gangrene. If suppuration has not yet occurred, elevation and gentle elastic compression with many layers of cotton-wool may be tried; if, however, this stage is already passed, more good may be done by means of warm fomentations and long-continued warm baths, assisted by thorough drainage.

If the skin is hard and brawny, with severe pain and throbbing, incisions should be made without hesitation. It is no use waiting until fluctuation, or even local softening, can be detected; they should be made before this, for the purpose of relieving the tension and allowing the inflammatory exudation to drain away. It is better to make them where the need is not absolutely certain than to leave them unmade. The depth to which they should be carried varies naturally with that of the inflammation; in most cases it is not necessary to do more than incise the deep fasciæ, and, as a rule, they should not be more than an inch and a half or two inches long. In planning them regard should, of course, be paid to the position of important structures and the natural folds of the part. The hemorrhage is not unfrequently profuse for a short time, but it can always be checked by the pressure of some absorbent gauze or other similar material. Afterward warm fomentations may be continued, so as to encourage the discharge as much as possible.

Other incisions may be necessary after the inflammation has ceased to spread, for the purpose of releasing sloughs or to give better exit to the discharges; and then, as granulations spring up, every attempt must be made to procure cicatrization as soon as possible. Some contraction is nearly always left, and often the tissues are extensively matted together, so that they remain cold and œdematous, but if the part is not hopelessly disorganized, very great improvement may generally be effected by constantly-repeated massage, warm douches, and shampooing.

In the worst cases, in which the joints are involved or the skin is extensively destroyed, amputation may be required, but it should not be performed until the acute symptoms shall have subsided.

## PYÆMIA.

Pyæmia is an infective disorder, caused by the ordinary pyogenic micro-organisms, and distinguished from the other affections to which they give rise by the unusual prominence of some of the clinical and pathological features—rigors, metastatic abscesses, and diffuse inflammation of the serous and synovial membranes in particular. It is not a specific disease; there is no evidence that other organisms than the ordinary pyogenic ones, the staphylococci and streptococci, are ever present. It is not even a disease of itself; it is merely the product of the ordinary germs that cause suppuration acting under peculiar conditions. If these organisms are rubbed into the skin so that the hair follicles are affected, they cause boils; under other circumstances, where the subcutaneous tissue is especially dense, they give rise to carbuncles; when the tissues are poisoned, either by the products of septic decomposition or by the ptomaïne of a snake-bite, diffuse cellulitis follows; if syphilis is present, phagedæna may occur; if the body is poisoned by the inhalation of the exceedingly virulent substance thrown off by the lungs, hospital gangrene and sloughing of the most extensive character are produced; and under certain conditions they give rise to pyæmia.

The anatomical structure of the injured part is one. Pyæmia is especially liable to occur in injuries of parts in which there are large veins unable to collapse —such, for example, as the diploë of the skull, the medulla of other bones, and tissues infiltrated with inflammatory deposit. The method of dissemination is another, dependent to some extent upon this. In diffuse inflammation of the cellular tissue, the organisms spread either by means of the lymphatics, or in the connective-tissue spaces; in pyæmia, the vehicle is the blood itself. For this reason, too, the infection is not a slow and gradual process, in which the neighboring tissues are overcome layer by layer in a widening circle, but immense quantities suddenly enter into the circulation, and are carried at once to a distant part. Another condition of very great importance is the presence of some foreign material in the blood-stream to cause embolism. The usual one is a fragment from some disintegrating blood-clot; but experimentally it has been shown that perfectly inert matter, which can only act mechanically, is quite capable of producing the same effect. The mere presence of pus-microbes in the circulation (unless the amount is so large that they of themselves act as an embolus) is not sufficient to cause pyæmia; but if particles of cinnabar are injected at the same time so that they become impacted in the arterioles and injure the endothelial lining of the vessels, characteristic metastatic abscesses are produced. That form in which diffuse inflammation only occurs, without evidence of embolism, is distinguished sometimes as pyæmia simplex. In addition to these there are other conditions, less well known, which probably are not without influence; the sudden entry into the circulation, for example, of considerable quantities of [illegible] causing fever; the development, in connection with the multiplication of germs, of substances which render the pus produced under these circumstances less adherent, possibly, the inefficient excretion of the [illegible] retained in the system when the kidneys are diseased: [illegible]. They do not cause the pyæmia [illegible] instead of, or in addition to, other [illegible] the same germs.

[illegible] the use of ward sponges, over-[illegible] suppurating wounds, and, briefly, [illegible] the other forms of infective [illegible]

Pathology.—[illegible] as a rule, there is a great [illegible] the red ones show signs of [illegible] irregular masses without [illegible] both free and

Sometimes the wound is apparently healing well, although a certain amount of suppuration is nearly invariable. More frequently it is foul and sloughing, with an offensive or ichorous discharge. The veins running from it are usually filled with softened clot; the infective organisms spread from the surface of the wound to the cellular tissue around the vessels and invade their walls; as the intima is approached a thrombus forms, and spreads farther and farther along the interior in advance of the inflammation. If the tissues are healthy, this prevents general infection; organization sets in, and the poison is shut off. If, on the other hand, the nutrition of the tissues is feeble, or the power of the germs unusally great, or a fresh injury of any kind is inflicted upon the part, degeneration follows instead of organization; the clot softens and breaks down; fragments of it are carried off into the blood-stream; and with them the cocci which have gradually worked their way through the wall. When pyæmia starts from a wound that is healing without suppuration, or, as in acute suppurative osteomyelitis, when there is no wound at all, the thrombosis must be explained in another way. The micro-organisms of suppuration are of common occurrence in the circulation—at least, they can enter easily enough; ordinarily they are innocuous; the tissues are able to resist their action; if, however, nutrition fails, whether from constitutional or local causes, or the endothelial lining of the vessels is injured, at once they make good their hold, coagulation-necrosis begins in the vessels, thrombi are formed, and, if the other conditions are favorable, pyæmia follows.

Intravascular infection of this kind may occur even in children who are to all appearance in perfect health. Probably in them it is rendered possible by some temporary depressing cause: want, injury, over-exertion, or exhaustion and fatigue. When pyæmia has already developed, it is of frequent occurrence, and thrombosis in distant parts of the body, especially in places that have been bruised or injured, with the attendant consequences of embolism and metastatic abscesses, is one of the usual symptoms.

Infection with pyogenic micrococci (whether they come through the walls of the vessels at the seat of injury, or enter in other ways), with its attendant thrombosis, leads to two kinds of abscess, one arising in connection with the veins and capillaries, the other embolic.

*a.* Of these, the former may begin either in the neighborhood of the wound, or in some distant part to which the micro-organisms circulating in the blood have been carried, and in which they have been arrested. In either case, the process and the consequences are the same. Thrombosis sets in; a ring of coagulation-necrosis forms round the germs; liquefaction follows; the clot, and then the walls of the vessels and the surrounding tissues, break down and melt away; and in a very short space of time an irregular cavity is formed, filled with a thin oily pus, colored in general from the mixture of a small quantity of hæmoglobin, and surrounded by tissues that are undergoing disintegration as rapidly as they can. The suppuration is always diffuse; there is no evidence of organization, and no sign of limitation anywhere. The connective tissue between the muscles melts away, leaving them literally dissected out by the pus; the synovial cavity of a joint, or a tendon sheath, is filled within a few hours; or one of the serous sacs is involved in the same way. In other words, there is diffuse inflammation of the cellular tissue, followed by suppuration and sloughing, as in the worst form of the so-called phlegmonous erysipelas.

*b.* Embolic abscesses occur in a different way. The thrombi in the veins, softened by the action of the micrococci, break down; loose particles are carried off in the blood-stream, and passing through the heart are driven into the vessels of the lungs. The smaller ones may pass through these, and then later be stopped elsewhere—in the liver, for example; the larger ones are arrested at the bifurcation of a vessel, and give rise to embolic abscesses.

The effect of a non-infective embolus depends upon the arrangement of the blood-vessels. If the collateral circulation through the part is good, no ill-result follows other than the obliteration of a short segment of the vessel. If the blood-

supply is entirely cut off, local anæmia and gradual disintegration ensue; but if, as in the case of the lungs, there is a condition intermediate between these two, the blood pours in from all sides, without strength sufficient to force its way out; the part becomes more and more congested; the walls of the vessels give way; the blood is extravasated into the tissues, and at length, when coagulation supervenes, the whole area is converted into a solid conical block. This is known as hemorrhagic infarction. It is common in the lungs and spleen, the base of the cone lying toward the serous surface; but it never occurs in the liver or the subcutaneous tissue.

When the embolus is infective from the presence of pyogenic micro-organisms, the same result ensues, but almost at once coagulation-necrosis follows, the central portion becomes liquid, and in a very short time the whole area of the infection, and the tissues for some distance round, are converted into pus. The change is so rapid as to resemble gangrene rather than ordinary suppuration.

The pathological appearances in a fatal case of pyæmia consist, therefore, with the exception of the changes in the veins, almost entirely of abscesses and suppuration, sometimes diffuse, sometimes embolic. Only one organ may be affected, or several; the abscesses may be all visceral, or all superficial. In some cases only one tissue is affected; in acute suppurative periostitis, for example, the lesions may be limited to the bones; in some forms of chronic pyæmia to the subcutaneous tissues; in others—those especially that occur after the acute exanthemata—to the joints. Pericarditis, due to infective embolism of the coronary artery, is exceptionally frequent in suppurative osteomyelitis, pleurisy in otitis; and abscesses in the liver when the urinary organs are involved; but, except in this last-mentioned case, no satisfactory explanation for such coincidences is forthcoming.

**Symptoms.**—No wound is exempt; it may occur without one, but it rarely breaks out without distinct evidence of suppuration, or, at least, of the presence of pyogenic germs. Sloughing wounds, and those which are foul from the presence of septic discharges soaking into and poisoning all the tissues round, are naturally more liable than those covered with healthy granulations; and septic fever and sapræmia are nearly always present as well.

It may begin insidiously, the temperature becoming more and more irregular and the patient failing distinctly, without its being possible to say that pyæmia has set in; or all of a sudden an intense rigor may commence without warning, and the temperature rise at once five or six degrees. After this it may fall again, but the characteristic feature is its extreme irregularity; rigors may occur every day, sometimes with such even intervals as to suggest ague; two or three may be present in the twenty-four hours; or there may not be one for a week; but, as a rule, the temperature is always suggestive of them, sudden and rapid rises occurring here and there without external causes.

The pulse and respiration vary with the temperature, gradually becoming more rapid and powerless as the patient fails in strength; any sudden change in either by itself is suggestive of fresh local trouble. The expression of the face is always peculiarly anxious, especially as each rigor comes on. The conjunctiva is often distinctly jaundiced, and the color is earthy, if not yellow. The tongue is red and smooth at first, later covered over with brown crusts; herpes is often present, leaving painful cracks and fissures in the lips; the teeth are covered with sordes, and aphthous ulcers are often scattered over the mucous membranes. Emaciation is generally exceedingly rapid, and in itself is highly suggestive; the breath, and sometimes the whole body, exhales a peculiar offensive mawkish odor; the skin is marked by fugitive erythemata of a dusky red; sometimes vesicles, and even pustules, form upon it; and in many cases it is exceedingly sensitive, the least touch causing the most intense pain. Delirium is not common, unless the temperature is continuously high, until the strength gives way. Vomiting often occurs with the rigors; albuminuria is present in a very large proportion; but diarrhœa is unusual.

In addition to these symptoms, which are dependent upon the changes in the blood, others arise from the local troubles. Any serous or synovial membrane may be affected; abscesses may form in any part of the body, deep or superficial; the viscera may be riddled with them; or they may be scattered through the subcutaneous tissue; and wherever they occur, they are always diffuse. Many of these cannot be diagnosed; metastatic abscesses in the lungs, for example, are always small, and cause but slight physical signs, while the nervous system is so depressed that the pain, even when it is severe, is scarcely felt. Local tenderness is always of very great significance; and in most cases it is essential to institute a thorough examination of the patient every day to make sure that no suppurating focus anywhere is overlooked.

Pyæmia varies very greatly in its intensity. In some cases—when, for example, it is due to acute osteomyelitis—it may prove fatal within the week, even before metastatic abscesses of any kind have been able to make their appearance. In others pericarditis, or some other lesion so grave as to imperil life, sets in almost at once. Sometimes, on the other hand, it is very chronic, lasting even for months, with occasional rigors and abscesses, which in these cases are limited, or almost limited, to the subcutaneous tissues. So far as the prognosis is concerned, a very great deal depends upon the locality of the secondary deposits. When the abscesses are superficial or confined to the joints, and when the fever does not run an extreme course, there is always the hope that recovery may follow, but at the expense of a long and tedious illness, with very likely one or more joints crippled and almost useless.

**Treatment.**—When once pyæmia has developed, it does not appear possible to cut it short in any way; all that can be done is to treat the symptoms as they arise, and prevent them from becoming themselves centres of fresh infection. Prevention, therefore, is all the more essential—first, to prevent the poison developing; secondly, to prevent its being absorbed.

Where it is practicable, every patient before operation should undergo a thorough course of preparation. It is a well-known fact that people in a robust state of health, taking active exercise, and consuming a large amount of food, are not nearly such good subjects for operation as those who have long been bed-ridden. Laid up suddenly, their bowels become confined, their liver is congested, the urine is thick and high-colored, and a certain amount of feverishness sets in.

The surroundings should receive the greatest attention. Ventilation should be perfect; nothing tends to such depression as the constant breathing of air that has been fouled; and absolute chemical cleanliness must be insisted on. Bed, bedding, instruments—everything, in short, that comes in contact with the patient—must be scrupulously clean. Outbreaks of pyæmia have been traced to the sudden disturbance of accumulations of dust, but in the majority of instances it is probable the actual vehicle of the poison is some material object.

A wound requires even greater care. Everything that tends to irritate the tissues in the neighborhood—want of rest, tension, friction, or decomposition—lowers their power of resistance and makes them more susceptible. Where the drainage is perfect, so that the discharges escape at once, and the surface of the wound is kept dry, so that decomposition cannot occur, suppuration may follow, but it will be limited to the surface, and there is little or no fear of the pyogenic micro-organisms either finding their way into the cellular tissue and causing diffuse suppuration, or entering into the blood-stream and leading to thrombosis, softening, and metastatic abscesses.

Abscesses should be opened at once and thoroughly drained. Joints that are filled with pus must be treated in the same way, or irrigated with a continuous stream of water. At first, the cartilages and the synovial lining are unaffected, and if only the contents are evacuated in time, and no accumulation is allowed, the mischief may be prevented from extending farther, and a very useful articulation left. In many instances, however, either fibrous or bony ankylosis results.

The same plan has been tried with the serous membranes, but it is scarcely sible to hope for success with them.

Quinine is of some use in controlling the temperature, and appears to c the onset of the rigors and diminish their severity, but not to the same exte in the case of urethral fever. Germicides taken internally are of no a secondary deposits make their appearance even when the urine is almost from the absorption of carbolic acid. Salicylate of soda and antipyrin m tried; and opium is always of use, both to relieve the pain and anxiety and cure sleep. The food should, of course, be as nutritious as possible, an supply of stimulants should be guided by the condition of the pulse.

[Pain should be controlled by an anodyne, and beef-tea, with bran milk punch, freely administered.]

# CHAPTER IV.

## *DISEASES DUE TO INFECTIVE ORGANISMS.—Continued.*

## 2. SPECIFIC.

### ERYSIPELAS.

Two kinds of erysipelas are clinically distinguished—simple cutaneous and phlegmonous. In the latter, however, the skin is involved secondarily; the true erysipelatous rash is not present, and there is no question that the inflammation is due entirely to the ordinary forms of micrococci.

Erysipelas is an acute infective inflammation of the capillary lymphatics, caused by the presence of a micrococcus. The skin is, generally speaking, involved, but sometimes it commences on the mucous and even on the serous surfaces.

**Cause.**—A streptococcus can always be found in the lymphatic spaces at the edge of the extending inflammation, chiefly in the superficial part of the corium and the subcutaneous fatty tissue; it is not present in the blood-vessels. Whether it is the same as the streptococcus of suppuration (S. pyogenes) or not is still doubtful. According to Fehleisen, it is not; by itself it never leads to the production of pus; if this occurs, it is always the result of a mixed infection. According to others, however, all the differences may be explained by the method or site of inoculation, the degree of attenuation, or the individual power of resistance. Morphologically they cannot be distinguished, although it is said the micrococcus erysipelatis is slightly the larger of the two.

It is very doubtful if the micro-organism can gain access otherwise than through a wound, but the smallest scratch or abrasion is enough. Exposure to draughts, sudden chills, the east wind, and the like, which are occasionally followed by an attack, and which certainly predispose to it, must be regarded as depressing agents, rendering the tissues more liable to infection. Erysipelas is occasionally epidemic, and probably may be conveyed by air or water; but it is certainly contagious and is especially liable to be disseminated by dirty hands or sponges.

FIG. 6.—Streptococcus Erysipelatous. Pure Culture in Bouillon at 37° C. Stained with Fuchsin. × 950. (*Baumgarten.*)

The predisposing causes include everything which can either impair the general health or weaken the power of resistance of the tissues in the neighborhood of the wound. Among the former are included Bright's disease, intemperance in food as much as in drink, gout, exposure, and privation. Overcrowding, the continued breathing of air loaded with the exhalations from other people's lungs, want of cleanliness, and general neglect of ordinary hygienic principles probably act in the same way; they all appear to interfere with the elimination of waste material of one kind or another, and so prevent the perfect nutrition of the tissues. Mechanical irritation, want of rest, congestion, or œdema, and the presence of foul or decomposing discharges soaking into the neighborhood of a wound, affect the surrounding structures, lowering their vitality and rendering them less capable of resisting. Under conditions of this kind the tissues, which, so long as they are healthy, are able to prevent the entry of foreign organisms and destroy, sooner or later, those that from some accident may have entered in, seem to lose their power of resistance altogether. Experiments in illustration of this have been performed by many observers. Chemical ferments, apparently containing no organic structure

of any kind, have been injected into the blood, and in a very short time it has been found that micro-organisms were present in myriads.

One attack distinctly predisposes to another.

**Pathology.**—Micrococci, forming chains, are found abundantly in the superficial lymphatics of the skin where the rash is spreading—not where it is fading, nor where it has passed away; they are much more scarce in the interstices of the tissues (though these anatomically belong to the lymphatic system), and are scarcely found at all in the vessels of the part. The other local changes are merely those that are present in ordinary inflammation—dilatation of vessels, accumulation of inflammatory exudation, and of leucocytes.

In fatal cases the blood is usually said to be fluid and uncoagulated, staining the interior of the heart and vessels. The spleen is soft and diffluent, the kidneys are engorged, sometimes showing signs of a catarrhal or interstitial inflammation, and the lungs are much congested, the smaller vessel being plugged with granular masses, which are supposed to be produced by the disintegration of white corpuscles. A similar change has been described in the vessels of the brain.

**Symptoms.** 1. *Constitutional.*—These usually precede the local ones by some hours, occasionally longer. There is a rapid rise of temperature to 102° or 104° F., with chills, or even a rigor; vomiting, epistaxis, and, in children, convulsions are of common occurrence. The skin is hot and dry, the tongue is coated with a thick, creamy fur, the bowels are confined, and there is headache with general depression. The temperature usually continues high for three or four days and then gradually sinks, assuming the remittent type, but as it rises again with every local extension its course is rarely uniform. In the worst cases the symptoms are of a typhoid character almost from the first; the eyes are jaundiced, the skin is a peculiar dusky yellow, the pulse is very small, frequent, and feeble, diarrhœa is often profuse and sometimes very offensive, albumin is present in the urine (perhaps owing to the catarrhal inflammation), and there is a constant, muttering delirium, which may be due to the plugging of the cerebral capillaries.

2. *Local.*—The redness nearly always begins at the margin of the wound, sometimes where the skin is continuous with mucous membrane, as at the angle of the eye, or on the mucous membrane, very rarely some distance off. At first it is a bright rose-red; exceptionally, and only in severe cases, it has a dusky tinge. The edge is irregular, but always sharply defined; even when the rash is advancing it always marches by steps, suddenly showing a well-marked border some distance off. The skin is swollen, œdematous, and pits on pressure. The raised margin can be felt, it is so clear. Where there is an abundance of loose cellular tissue, as in the eyelid or the scrotum, the swelling becomes enormous in a very short space of time, but the pain is very slight. When, on the other hand, the skin is tightly bound down, as over the nose or the pinna, the color is livid, the swelling slight, and the pain intense. Very often in these circumstances the epidermis is detached from the corium beneath, forming bullæ, which at first contain clear serum, but soon become full of pus. As the inflammation subsides these burst, dry up, and form scabs, but there is no ulceration or destruction of the cutis. In severe cases the fluid they contain is stained with blood.

The neighboring lymphatic glands are always swollen and tender; very often this is the earliest sign, and it is usually present before the blush shows itself. As the disease advances the redness involves one area after another, fading in the centre as it spreads by the circumference. Sometimes this continues for two or three days only, sometimes for much longer periods, until perhaps the greater part of the body has been traversed. Then the temperature falls suddenly, the last-formed red patch ceases to spread, the swelling disappears, the skin becomes wrinkled again, and the pain and tenderness disappear. Desquamation always follows a severe attack, and when the head is involved, the hair falls off, but it speedily grows again.

In rare cases erysipelas is erratic, disappearing in one part and breaking out

in another; and, in very exceptional instances, metastatic, suddenly subsiding and attacking some internal organ instead.

Abscesses are uncommon, although occasionally the lymphatic glands break down and suppurate. Very often a relapse occurs, sometimes two or three, but they are rarely so severe as the original attack. Acute suppurative arthritis, meningitis, pleurisy, and peritonitis have been recorded as complications; and occasionally in erysipelas of the face the mouth and fauces become involved, leading to erysipelatous laryngitis and œdema of the glottis. Pyæmia occasionally follows it: and sometimes, especially after repeated attacks, a condition of solid œdema is left, which is very disfiguring when the face is concerned.

**Diagnosis.**—The sudden rise of temperature, with headache, vomiting, and constipation; the enlargement and tenderness of the neighboring lymphatic glands; and the peculiarly sharply-defined margin of the redness, are characteristic. The last serves to distinguish it from simple lymphangitis.

Erysipelas commencing in the mucous membrane of the fauces resembles ordinary catarrhal pharyngitis, but is infinitely more severe. The constitutional symptoms are even more marked than in the ordinary cutaneous form; the throat is swollen and burning hot; the mucous membrane of the palate is thickened and of a brilliant red; the voice is lost; swallowing is exceedingly painful; and the glands at the angles of the jaw are enlarged and very tender. The prostration in these cases is usually extreme, and, in addition to the ordinary risks, there is always the fear of the inflammation extending to the larynx.

**Prognosis.**—The severity of the initial fever is no guide. [In youth and middle age recovery is the rule.] At the extremes of life; when the head, face, or chest is involved; when the disease continues for any length of time, and particularly when there is old-standing nephritis, the prognosis becomes very grave. A dusky red, instead of bright eruption, jaundice, delirium, blood-stained bullæ, and a sudden rise in the pulse-rate, without strength, are very serious omens. In many cases broncho-pneumonia sets in and proves fatal; in others signs of congestion of the brain; in others, again, the symptoms resemble those of typhoid with diarrhœa; or the patient sinks from exhaustion, worn out by the long-continued fever.

**Treatment.** 1. *Constitutional.*—It must always be remembered that, although the fever at the commencement of an attack may be sthenic, it tends very rapidly to assume a typhoid character.

A purgative is nearly always required at first; even when there is diarrhœa it may usually be given with advantage, and particularly when, from the patient's appearance or habits, it is probable that the liver is congested. Afterward the bowels may be kept gently open by means of effervescent salines. In the slighter cases nothing else is required, though quinine with mineral acids may be given to stimulate the appetite. In the more severe ones, where the tongue is dry and brown, and the pulse is losing its strength and fullness, bark and ammonia with ether answer better than anything. If the temperature is high quinine or antipyrin may be given, but they appear to have little effect upon the disease. Perchloride of iron, which, according to some, acts as a specific when given in large and frequent doses, has in my hands failed completely. I have often noticed a distinct improvement when it has been left off and quinine and carbonate of ammonia substituted.

Stimulants are usually required, especially in the aged and in those who are accustomed to them. The guide to their administration is the condition of the tongue and the pulse. They should always be given in small quantities at a time, and, if possible, with beef-tea, meat-jelly, milk, arrowroot, or other food that can be easily absorbed. The object is to sustain the action of the heart and supply it with strength until the activity of the poison begins to subside. Very often after the first day or two the patient will take liquid food readily, and then there is not the same necessity.

2. *Local.*—Many attempts have been made to check the spread of the micro-organisms in the tissues, but not with any great success. Injections of carbolic

[illegible] of soda are recommended. American surgeons are [illegible] vapor and creasote with advantage. Salicylic acid is [illegible] when injected hypodermically; and many other germi- [illegible] reputation. In most cases, however, it answers better [illegible] Strong antiseptics in particular should be avoided, as the [illegible] upon the tissues may cause sloughing.

[illegible] can be relieved by excluding the air and using gentle [illegible] be grateful to the patient, but care is required in employing [illegible] the vitality of the part too far. Oxide of zinc and starch [illegible] thickly over the skin, but in many cases they cause intoler- [illegible] Extract of belladonna mixed with glycerin, and covered with a [illegible] of cotton-wool, is greatly to be preferred. Three or four coats of [illegible] mixed with glycerin to prevent its cracking, have a very satisfactory [illegible] no doubt, owing to the absorption of the lead and its action upon the [illegible] but the ordinary lead lotion is equally good if evaporation is checked [illegible] five or six thicknesses of lint. In very mild cases the surface may be [illegible] with a strong solution of nitrate of silver in ether, or with collodion, [illegible] of iodine, though the benefit is probably due to the mechanical effect [illegible] the epidermis.

Rest, gentle uniform pressure, and elevation, if the part will admit of it, are [illegible] help in relieving the pain and inflammation. When the tension is [illegible] it is sometimes necessary to make a few punctures: for want of this I have [illegible] the eyelids slough, but such circumstances are rarely met with in uncom- [illegible] erysipelas.

Occasionally the application of a blister to the sound skin, by temporarily excluding the lymphatics, may prevent the spread. The tincture of iodine is [illegible] and is potentially germicidal. Vapor of bromine is useful in prevent- [illegible] the spread to other patients.]

## SEPTIC INFECTION, OR TRUE SEPTICÆMIA.

In the strict sense of the term this name should be reserved for an acute specific disease caused by a micro-organism which multiplies in the blood, so that the most minute trace can communicate it by inoculation, as in the case of anthrax. It is not of necessity attended by septic fever or sapræmia, on the one hand, or by the local manifestations of pyæmia, thrombosis, embolism, or suppuration, on the other. The smallest wound is sufficient: there is a short period of incubation (eight or ten hours in acute cases—and the symptoms steadily increase in severity. Sometimes it is known as progressive septicæmia to avoid confusion with sapræmia.

That such a disease can be artificially produced by pure cultivations in animals is beyond doubt. Whether it ever occurs in man by itself, so that it can be distinguished from all other troubles that are caused by infective germs, is open to question. It must be remembered that after the injection of a minute quantity of a chemical poison into the blood, myriads of micro-organisms make their appearance, and care must be taken not to mistake effect for cause.

It is possible that some of the exceedingly fatal cases of post-mortem wounds that occur in connection with puerperal peritonitis are examples of septic infection; but, on the other hand, it is by no means improbable that they are really due to sapræmia, the inoculation of a virulent poison (as happens sometimes from the bites of venomous reptiles) causing such extreme depression that the tissues either succumb at once, or are too much weakened to withstand the action of other germs. Other examples are fortunately very rare.

**Pathological Appearances.**—The changes found *post-mortem* are practically the same as those in other acute specific fevers. Cloudy swelling is universal; the brain and pia mater are congested: the spleen is enlarged; and the number of white corpuscles in the blood apparently increased: but in th[illegible] ute cases

there is nothing more definite. In those which have lasted a little longer, or in which the temperature has been very high, petechiæ may be found upon the skin and the surface of the serous membranes, and sometimes these and the lining membrane of the heart show evidence of acute inflammation. Unless, however, the endocarditis has distinctly assumed the ulcerative form, embolism does not occur. When the disease has lasted longer it is usually complicated by the presence of local inflammation.

**Symptoms.**—The wound itself may have been absolutely unnoticed, but usually it is inflamed and painful, and sometimes there is tenderness running from it in the direction of the lymphatics. Otherwise it shows no change. The general symptoms commence, as a rule, about eight or twelve hours after the injury, with the most overpowering depression; headache is extremely severe; there may be a rigor of great intensity, but very seldom more than one; the temperature begins to rise at once, the pulse is small and feeble from the first, the respiration is hurried and shallow, and in a very short time delirium sets in, and

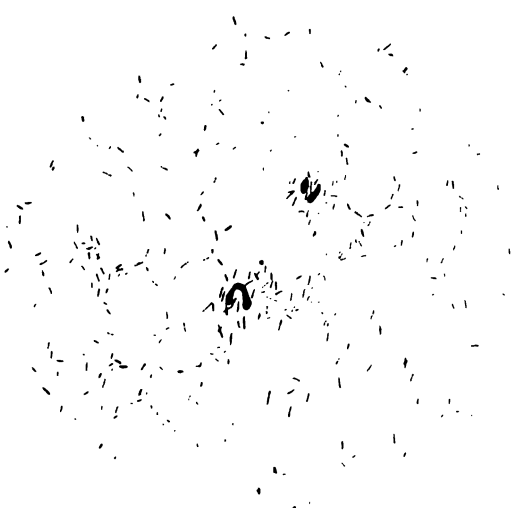

FIG. 7.—Blood of a mouse killed by inoculation of the bacillus of mouse septicæmia. A thin layer of the blood has been dried on a cover-glass, carefully heated, stained with a watery solution of methyl blue and mounted in glycerin. (× 700).
White blood corpuscle with horseshoe-shaped nucleus, and numerous minute bacilli in and around it. Red blood corpuscles. Small bacilli between corpuscles. (*After Woodhead.*)

stupor and coma rapidly follow. The central nervous system from the first is entirely overcome. Sometimes there is a rash upon the skin not unlike that of scarlatina. Lung complications are of frequent occurrence. Diarrhœa may be present, and albuminuria, after the first two days, is almost invariable. Later, if the case becomes chronic, inflammation of the serous membranes and of the endocardium may set in, and various local troubles, with sapræmia and suppurative fever, may make their appearance.

The diagnosis from sapræmia is practically impossible [except from the history of the case], although septic infection is more probable when there is a distinct incubation period. No other diseases occurring under such conditions ever cause symptoms of such severity.

Treatment is of little use. An attempt should be made to limit further absorption by the thorough application of caustics: there is evidence to show that, in the case of some other acute specific and infective disorders, destruction of the seat of inoculation is of considerable benefit. Quinine and antipyrin may be

given when the temperature is high, and stimulants—alcohol, ammonia, and ether—if the pulse shows signs of failing. Otherwise, nothing is of much avail; the case usually terminates fatally in a few days [but it may be prolonged for many weeks. Mercurials, in minute doses, are said to be beneficial].

## ANTHRAX.

Anthrax, or malignant pustule, is an acute infectious disease, caused by a specific bacillus. Woolsorters' disease is the same thing under a different form, and so is the splenic fever of cattle. The bacillus anthracis is the largest and most easily recognized of pathogenic organisms. It consists of rods, from five to ten micromillimeters in length, abruptly cut at the ends, and capable, under suitable conditions, of producing spores which possess the most extraordinary powers of resistance; their tenacity of life is so great that catgut prepared for ligature in the ordinary way and kept in a dilute solution of carbolic acid has shown itself capable of transmitting the disease. It can grow in the tissues, or in the blood, or outside the body, provided there is a sufficient supply of oxygen and the temperature is kept up. Naturally, those are most exposed to it who have to deal with hides, wool, etc.: tanners, dock laborers, woolsorters, and others, but it may occur in butchers, and there is evidence to show that it has been transmitted by flies.

The mode of entry is either through the skin—as in malignant pustule and some cases of malignant œdema—or through the mucous membrane of the respiratory or alimentary tract (woolsorters' disease). In the former case, characteristic local changes precede the clinical symptoms; in the latter, the bacillus enters at once into the blood-stream, penetrating, so far at least as the lungs are concerned, between the uninjured epithelial cells. Each of these forms, as the infection spreads through the body, may be attended at a later period by the primary lesion that is characteristic of the other; thus, if the patient lives sufficiently long, malignant pustule may develop upon the skin in a case of woolsorters' disease, and secondary intestinal anthrax may show itself in the course of malignant pustule.

The bacilli themselves may be found in enormous numbers at the seat of infection, in the inflammatory effusion that is poured out round it, and in the fluid of the vesicles that lie upon it. They are also present in the blood, especially where, as in the spleen, the circulation is slow; and they exist abundantly in the ecchymoses that are found in the mucous membranes and under the serous coverings of the viscera.

The period of incubation is very variable—from a few hours to ten days, and even more—probably depending upon the dose and upon the facilities for general distribution afforded by the anatomical structure of the part. The mode of action is, to a certain extent, mechanical, but the chief effect is due to the production of some substance (an albumose, in all probability) at the expense of the tissues. In patients who have survived, the bacilli have been found in all the excreta, and in one remarkable case, recorded by Davies Colley, they were still present in the urine a month after the man had recovered from the attack.

Recently, it has been shown by Hankin that an albumose possessing similar toxic properties can be extracted from a cultivation of anthrax, and, further, that minute doses of the same, given previously to inoculation, confer a certain degree of immunity, while large ones only hasten the result.

**Morbid Anatomy.** The pathological appearances in the case of anthrax are very similar to those that occur in other forms of acute blood-poisoning. Decomposition is rapid, the blood does not coagulate, all the viscera are congested, the spleen in particular, and sometimes the mesenteric glands are enormously enlarged. There is a blood-stained effusion in all the serous sacs, and hemorrhages are not unfrequently present in their walls. Ecchymoses are common, on the mucous surface of the intestine, sometimes forming raised blackened patches, which are surrounded by a zone of gelatinous infiltration, similar to that in the primary affection upon the skin, and occasionally sloughing has commenced already.

The seat of infection, if it is on the skin, shows no sign of suppuration; all the angry redness and much of the swelling disappear *post-mortem;* the centre forms a hard, blackened slough; round it the tissues are filled with a blood-stained fibrinous effusion; and further away all the parts, sometimes for long distances, are infiltrated, œdematous, and dark with hemorrhages. Bacilli are present in abundance throughout the whole infected area and in the ecchymoses.

**Symptoms.**—The constitutional symptoms, as in septic infection, are those of the most intense depression, whether the poison enters by the skin or the mucous membrane. In some cases, especially in malignant pustule of the face and neck, there is a delay of only a few hours; in others more than a week may pass; then the temperature begins to rise and becomes exceedingly irregular; shivering sets in, with general pains all over the body; the pulse becomes small and feeble; sometimes there is cyanosis, and occasionally severe dyspnœa from œdema of the glottis. General cramp, diarrhœa, and vomiting are of frequent occurrence; some-

FIG. 8.—Bacillus anthracis from the spleen of a cow that succumbed to an attack of splenic fever. The specimen was taken some time after the organ had been removed from the carcass, and in presence of air, spores had begun to form in the bacilli. Specimen was dried, heated, stained by Gram's method, with methyl violet and vesuvin, and mounted in Canada Balsam. (× 700.)
The anthrax rods and filaments, some of them with bright points or spores, are stained with methyl violet. The cells of the splenic pulp are stained brown by the vesuvin. (*After Woodhead.*)

times there are convulsions, especially toward the end; or the patient becomes delirious and comatose. In other cases, the symptoms are typhoid almost from the first. Death usually occurs from heart failure, sometimes rather suddenly; or it may be caused by asphyxia, especially when there is œdema of the glottis; or by fever and general exhaustion. Broncho-pneumonia and enteritis are more prominent, as a rule, where the infection is internal; but often in these cases the course is so rapid, and the constitutional symptoms so severe, that the physical signs are insignificant in comparison.

The seat of infection, when it is upon the skin—the so-called malignant pustule—is characteristic. A small, red, itching papule forms first. As the effusion increases, this becomes a vesicle, filled with blood-stained serum, resting upon an indurated base. Soon the vesicle breaks or dries up, leaving a blackened, central scab, or slough. The effusion continues to increase; an indurated area, raised considerably above the surrounding level, is rapidly developed; the surface becomes a peculiar purple-red, and ring after ring of vesicles form upon it round

## GLANDERS.

This is another variety of infective disease, caused by a specific germ, the *bacillus Mallei*. Like pyæmia, anthrax, tubercle, and, to a less extent, syphilis, it varies very greatly in different cases, the severity of the attack, and the nature of the symptoms being modified by the anatomical structure of the seat of inoculation, the method of dissemination, and probably the dose of the poison. It may be acute or chronic; it may affect especially the mucous membrane of the nose and the respiratory tract (glanders), or it may spread slowly in the cellular tissue and lymphatics (farcy); and, not uncommonly, after continuing in the chronic form for a greater or less length of time (I have known it upward of a year in a horse), it suddenly becomes acute; but, in all cases, although its manifestations and its course are almost as variable as those of tubercle or pyæmia, it is one and the same disease, caused by the same species of organism.

The bacillus is a small rod, somewhat shorter and thicker than that of tubercle, and usually exists in pairs. It is not capable of spontaneous movement, [and spores have been proved to exist by Baumgarten and Rosenthal]. Usually, it enters through wounds, especially at the corners of the nails; but, in all probability, it possesses the power of infecting the respiratory, if not the alimentary, mucous membrane. It may be transmitted from man to man, but, as a rule, it is caught directly from horses, or asses. Other animals show varying degrees of susceptibility to it.

Local changes are usually produced at the seat of inoculation; there is a period of incubation of some days, then the part becomes red and swollen; the skin breaks down, and a foul ulcer is left, spreading at its edges and its base, but without anything in itself characteristic. From this the organism spreads, with more or less rapidity, in the cellular tissue round, in the lymphatics, or in the blood, the severity of the symptoms and the acuteness of the attack depending to a very large extent upon this. Whenever it spreads it causes inflammation; granulation-tissue is produced; and this, as in the case of tubercle and syphilis, undergoes caseation (unless it is near a mucous or cutaneous surface, when it may break down at once), so that the yellowish-white, cheesy nodules and tubercles (farcy-buds, when they can be felt from the exterior), are formed in various parts. Suppuration follows, whether through the action of the specific bacilli, or because of the presence of pyogenic organisms in addition, is not known; and then ulcers, abscesses, and diffuse forms of inflammation break out in all the infected regions. The bacillus exists in the cheesy masses and in the pus; not unfrequently it can be found in the blood as well in man, but this does not seem to be the case with horses.

**Symptoms.**—It is met with, naturally, chiefly among those whose occupations render them liable to infection, and it may be acute, so that it proves fatal within three or four days, or chronic, lasting for months, and possibly ending in recovery after a long and severe illness.

The constitutional symptoms depend upon the acuteness of the attack. In the worst cases they resemble those that are always present in intense blood-poisoning—muscular tremors, low-muttering delirium, etc., with high fever, and a small, feeble pulse. When it is less severe they depend practically upon the number, size, and situation of the abscesses and ulcers, and upon the extent to which suppuration and septic absorption take place. In the majority of cases they do not terminate fatally at the commencement from the intensity of the fever; either broncho-pneumonia sets in, from the constant inhalation of the odor from the foul and decomposing sloughs, or the patient sinks at length from exhaustion, utterly worn out by pain, inability to take food, profuse suppuration, and fever. The most chronic cases recover, but always seriously crippled.

Glanders may commence with inflammation and ulceration of the mucous membrane of the nose, or this may occur later in the course of the disease. In the case of the former, it is probably due to direct infection. At first there is a

[illegible] purulent, watery discharge: this rapidly becomes purulent and exceedingly offensive, the inflammation spreads and becomes more and more severe: the whole of the mucous membrane of the nose ulcerates and sloughs: the bones are exposed and bare, already eaten away in places: the eyes, the frontal sinuses, the antrum, the pharynx, and palate are rapidly involved: and the whole of the face and neck become swollen, livid red, hot, and inflamed, as in the worst form of phlegmonous erysipelas. Such cases usually prove fatal at a very early period; one that I have seen terminated on the fourth day from the commencement of the disease.

In the chronic variety [illegible] the distribution of bacilli takes place chiefly in the [illegible] bodies form in the skin, the subcutaneous tissues, along the course of the lymphatic vessels, and then later, in the internal organs. On the

orders—syphilis, tubercle, pyæmia, etc. The steady persistence with which the swellings form, enlarge, and break down in spite of everything, must soon, however, attract attention.

**Treatment.**—This is similar to that of anthrax; the seat of inoculation should be thoroughly cauterized, and if the mucous membrane of the nose is involved, the whole cavity should be irrigated with carbolic acid, corrosive sublimate, dilute sulphurous acid, or perhaps sulphite of sodium. Abscesses must be opened and treated in the same way, and the general strength must be maintained as well as possible. If the nose is not infected, great care should be taken to prevent it. Probably this takes place in many cases secondarily, and is due to the patient himself conveying the poison to the mucous membrane. Recovery after this has happened is very rare.

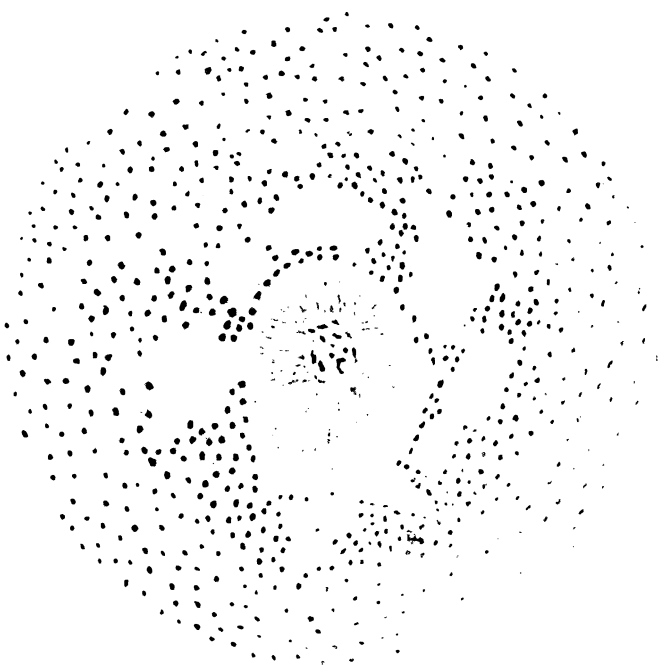

FIG. 10.—Actinomycosis. Tongue of cow. Section stained in Spiller's blue. (× 300.)
Centre of mass of conidia (conidiophore). Pear-shaped conidia. Endothelioid cells. Fibrillar tissue near the margin of the follicle. Spindle-shaped cells, seen especially near the margin. (*After Woodhead.*)

## ACTINOMYCOSIS.

Actinomycosis is a disease caused by a peculiar form of fungus that attacks herbivorous animals (including man), gaining access to the tissues either through wounds or through the mucous membrane of the respiratory or alimentary canal. There is some evidence to connect it with rye, and, perhaps, with barley. An epidemic occurred in Seeland, from eating rye grown on recently-reclaimed ground, and on two or three cases the disease has distinctly originated in a wound of the mucous membrane of the mouth, caused by a grain of rye, showing that at least it may be the carrier of the infection. In cattle it usually begins in the tongue or the jaws, generally the lower, and spreads thence to the cellular tissue of the submaxillary and cervical regions.

The fungus is easily recognized by its characteristic star-like masses of mycelium. The granulation-tissue that forms the tumors, and the pus in the

abscesses and ulcers, contain myriads of yellow, rounded bodies like millet-seeds Each of these is made up of little threads, which radiate, star-like (whence th name), from one common centre, and, after a time, enlarge and terminate in club like structures which probably contain spores. In cases of suppuration, however these are not always plain, and the color is not always so clear. Nothing i known with regard to its life-history, except that it has been found in the muscle of a pig, and that water and dilute saline solutions destroy it at once.

Infection usually takes place through the mouth, either from a wound o through some carious tooth; but the fungus has been found in the tonsil and a a primary growth in the tubular glands of the mucous membrane of the larg intestine. Cutaneous wounds are occasionally affected, and, from the fact that i has been found abundantly in the cavities in the lungs and in the pus from medi astinal abscesses, it is highly probable that, sometimes at least, the spores ar inhaled and, sinking into the alveoli of the lung, set up broncho-pneumonia Wherever it comes, it causes chronic inflammation, which closely resembles tha caused by tubercle, at least in its histological features. Giant-cells develop aroun the fungus; outside there is a meshwork filled with epithelioid cells, and outsid these again others resembling leucocytes. Caseation soon begins in the middle, and the nodules formed in this way continue to enlarge at the margin and decay at the centre, until, like tubercle, definite caseous masses, which sooner or later break down into pus, are formed at all the infected spots. Suppuration is probably always due to the coincidence of pyogenic germs, for occasionally nodules of very considerable size are found intact. As soon as it breaks out the disease assumes a much more rapid course, the constitutional symptoms become more severe, and septic fever, hectic, and very probably pyæmia (the particles of the fungus serving as the embolus), make their appearance as well.

**Symptoms.**—The disease at the beginning is usually chronic. Enlargement of the lower jaw, or an ill-defined swelling in the submaxillary region, or a reddish but painless nodule upon the skin, is often the first sign noticed, and for a time there is nothing to distinguish it from all other forms of slowly-growing granulation tumors. Wherever it is, it grows steadily, not involving blood-vessels or lymphatics at first. Then, sooner or later, suppuration begins, the pain and swelling rapidly become much worse, the size increases, the skin becomes red and glazed, and the constitutional symptoms become as severe as those of diffuse cellulitis or diffuse osteomyelitis. Secondary deposits soon follow, and, as might be expected, no organ in the body is exempt, caseous nodules and abscesses containing the characteristic millet-seed bodies having been found [illegible] even in the brain.

**Diagnosis.** [illegible]

**Treatment.** [illegible]

## TUBERCULOSIS.

Tuberculosis is an infective disorder caused by a specific micro-organism which gains access to the body either through the skin or the mucous membranes, and gives rise to characteristic changes.

The bacillus occurs in the shape of very thin, non-motile rods, from two to eight micromillimeters in length, and is found abundantly in the interior of the giant and epithelioid cells that constitute what is known as a tubercle. It is not present, with rare exceptions, in caseous *debris*, or the liquid material that fills caseous abscesses, although this is intensely infective. The probable explanation is that spores, which are formed in the body, and which have the appearance of vacuoles when seen under the microscope, are present, but are not stained by the ordinary reagents, and consequently are not recognized.

That this bacillus is the cause of tuberculosis, and the only cause, must be considered proved; it is always found in connection with tubercular deposits; it does not occur without them, and inoculations with a pure cultivation practically invariably give rise to local or general manifestations of tuberculosis. As, however, the changes that occur and the results that follow present an immense variety, it is clear that there are other causes modifying its action.

**Predisposing Causes.**—In large towns and in large institutions, especially where there is overcrowding, the tubercle-bacillus must be practically of universal

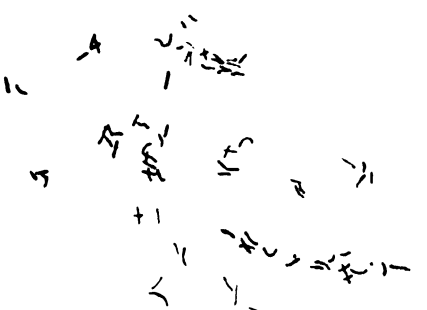

FIG. 11.—Tubercle Bacilli in Sputa. Stained with gentian violet. Contrast stain Bismarck brown, Weigert's method. (× 450.) (*After Woodhead.*)

distribution; yet only a few are attacked by it, and of those who are attacked a great many recover from it. It can only thrive in those who are in some way susceptible, whether this susceptibility is due to local or constitutional causes.

*Heredity* is of some consequence. There is no doubt that when full allowance is made for the effects of surroundings the members of some families are much more subject to tuberculosis than those of others. This tendency was, at one time, known as scrofula, and certain personal peculiarities were supposed to be associated with it; but as the name was allowed to include both the constitution which indicates a predisposition to the formation of tubercle, and the effects of the disease itself, it is better to drop it altogether. If its etymology is taken into consideration, it should be confined to those cases in which, from the thickening of the tissues of the neck (caused by the glandular enlargement), the hypertrophy of the upper lip, and the diminished prominence of the chin, the profile bears some resemblance to that of a pig.

The *general conditions of life* are probably of much greater importance. Everything that tends to lower the vitality of the tissues, overcrowding in particular, uncleanliness, bad food, exposure to cold and wet, or want of exercise and fresh air, increases the liability. On the other hand, the children of tubercular parents, even when they themselves are already the subjects of the disease, may recover, and, in many instances, completely regain their health, so that there is

no evidence of the disorder but the scars it leaves, if they are removed sufficiently soon to a proper climate and fed sufficiently well.

*Age*, again, is not without influence. Tubercular inflammation may occur at any time of life, even in old age, but it is very much more common among the young; and it is especially prone to attack those parts of the body which are at the time the seat of special functional activity—the lymphatic glands and the bones in youth, and the testes in adult life.

Every organ of the body may be attacked, although it is very much more frequent in some than in others. True tubercular ulceration is not common upon the skin, independently of lupus and anatomical tubercle, which are due to the same cause acting under special conditions. (Lupus, that is to say, always gives rise to tuberculosis when inoculated in animals, although the converse has not been observed; and bacilli apparently identical have been found in anatomical tubercle of the fingers.) In the subcutaneous tissue it forms cheesy nodules, which break down and leave sinuses lined with tubercular granulations. The mucous membranes of the respiratory, alimentary, and genito-urinary tracts are often attacked by it, the lymphoid follicles enlarging and breaking down so as to leave superficial ulcers, which slowly extend in depth and breadth until huge, ragged excavations are formed. The serous sacs are specially favorite seats for it. The synovial membranes of joints may be converted into gigantic masses of soft, gelatinous granulation by it. The bones, especially in children, are often involved, and not unfrequently the disease, which usually begins in the growing layer between the epiphysis and the shaft, spreads from it to the joint. The lymphatic glands naturally rarely escape, while all the viscera are more or less subject to it; the mamma, ovaries, thyroid gland, and the voluntary muscles being curiously free.

*Local predisposition* to tubercle may be acquired as well. If the vitality of any part of the body is impaired by injury, inflammation, over-use, etc., the tubercle-bacilli, supposing they gain access to it, have all the better chance of living. It is owing to this, among other reasons, that it is so often localized in joints, and that tubercular disease of the lymphatic glands of the neck is so frequent. It may, of course, be that the common form of eczema of the head in children which causes this enlargement is itself tubercular, and that the lymphatic glands are infected as a natural consequence: it is said, in proof of this, that tubercle-bacilli have been found among the epidermic cells: but it is scarcely possible that this is true of the carious teeth and of the inflamed and enlarged tonsils, which are not seldom the starting-point. It is enough that some slight irritation is excited in a lymphatic gland by the quantity or quality of the lymph passing through it: if once the tubercle-bacilli gain access to it—and they easily may through any abrasion—they are able to grow and thrive and prove the focus for a fresh dissemination.

Other circumstances, which cannot be called predisposing causes, modify the effect of the bacilli to a very considerable degree.

*The dose* is of importance. A single bacillus is probably enough. It is taken up by a leucocyte: this wanders some little distance in the tissues, and then, under the influence of the irritation, becomes transformed into a giant-cell, in which the bacillus multiplies. Clearly, however, the effect is likely to be much greater and more rapid when the infection is either a large one or frequently repeated: as when a patient continues to breathe air loaded with germs. As a rule, infection with small quantities gives rise to local manifestations.

*The method of infection* is another point. There can be now no doubt as to the possibility of infecting recent wounds. Many cases have been recorded in which wounds have gradually developed into tuberculous ulcers from which the bacilli have spread along the lymphatics to the neighboring glands. The period of incubation is said to be about three weeks: a red nodule forms at the point of inoculation: it slowly increases in size: the centre breaks down, discharging a minute cheesy mass, and a typical tubercular ulcer is left, with raised, reddened, and irregular edges, sometimes covered with granulations, and an uneven base,

inclined to bleed. In most cases, however, the bacilli enter the cellular tissue directly, either through inflammatory abrasions of the surface, as in eczema capitis and otorrhœa, or in the case of mucous membranes, even without this. In the lungs it seems probable that they may develop first in the epithelium that is heaped up in the alveoli in pulmonary catarrh.

The dissemination is chiefly regulated by the *anatomical structure of the part.* The bacilli may spread slowly in the surrounding tissue, and the seat of infection enlarge continuously without involving other structures. They may be carried into the lymphatics, and arrested for a time, or even permanently, in the glands. They may get into the blood-stream and rapidly spread all over the pulmonary or systemic circulation: the wall of a vein may be ruptured by some accident, or torn in some operation, or the tuberculous focus may gradually ulcerate through it and burst into the interior. The same thing may occur with one of the arteries, though much more rarely; and finally, if the lining membrane of one of the serous or synovial cavities is attacked, the infection may spread rapidly over the whole surface.

*The presence of a mechanical embolus*, although it may not be of so much importance as in the case of pyogenic micrococci, when in all probability it determines the formation of metastatic abscesses, is certainly of consequence in connection with tubercular arthritis. It is not uncommon to find that this has originated from a wedge-shaped sequestrum in one of the articular ends of the bones; and it is a fair suggestion that cutting off the circulation and lowering the vitality of the segment is of very considerable assistance to the development of specific germs.

As the action of pyogenic organisms is materially assisted by the *presence of septic decomposition*, the ptomaïnes formed by this soaking into the tissues, lowering their vitality, and rendering them less capable of resistance, so it is with tubercle-bacilli. If suppuration occurs in connection with a tuberculous cavity, the process of destruction becomes exceedingly rapid. On the one hand the pyogenic organisms grow with greatly increased vigor in the tissues that have been weakened by the tuberculous process; on the other, the risk of general dissemination is very greatly increased by the possibility of the walls of the vessels giving way.

**Pathology.**—Tubercle-bacilli, wherever they are implanted, at once set up chronic inflammation of a somewhat special character. The earlier changes are the same as with any non-pyogenic germ; the capillaries dilate, more plasma pours through, and the leucocytes collect in larger numbers. Then, however, an enormous multinuclear cell develops at each point of infection, so peculiar in its appearance that for a long time it was believed to be a formation special to tuberculosis.

The most typical tubercles are the youngest, those which are firm and gray, standing out from the tissues around as minute, but distinctly circumscribed, masses. Each of these is made up of smaller ones, containing in their centre a giant multinuclear cell, and sending out in all directions processes which branch and form a kind of network. In the meshes, round the central mass, lie other cells, known from their general appearance as epithelioid; and these in their turn are surrounded by numbers of smaller ones, identical with ordinary leucocytes. In this, however, there is nothing peculiar but the regularity of the arrangement. Structures precisely similar may be produced by other causes than tubercle-bacilli; similar giant-cells can be found in any chronic inflammation, especially those forms which are poorly supplied with vessels; and they are surrounded by similar groups of epithelioid and lymphoid corpuscles. The specific character is due to the tubercle-bacilli, which can be found in the central mass, and in and between the epithelioid cells.

The semi-translucent, gray, non-vascular nodules formed in this way are typical of tuberculosis. Sometimes, in the infiltrating form of growth, they cannot be recognized in the masses of round-celled granulation-tissue thrown out as a

[illegible] forming a ring [illegible] invading all the tissues near, and spread[illegible]

[illegible] to degenerate [illegible] The degeneration and [illegible] and as the inflammation continues to spread at the margins and [illegible] the central portions masses of what is sometimes called crude or yellow [illegible] are formed, the centre soft and cheesy, the margin consisting of typical [illegible] which, being situated at the part already furthest degenerates.

*Progress.* [illegible] from the relative vigor of the tissues [illegible] the anatomical structure of the area involved, and the opportunities [illegible] afforded the bacilli.

*Abscess* may occur. The bacilli, unable to make head [illegible] cease to extend, and perish. The outer wall of leucocytes throws [illegible] the healthy tissues around, and the usual inflammatory organization sets in, and a [illegible] capsule is formed, shrinking and becoming harder year by year [illegible] a little caseous or calcareous mass, which may remain quiet for the rest of [illegible] but which is always liable to become the source of future mischief.

*Liquefaction* may take place. As the caseous centre increases in size, espe[illegible] [illegible] a [illegible] of mucous surface, it gradually becomes more and more [illegible] at length a cavity is formed, filled with a fluid which in extreme [illegible] resembles pus, and which used to be taken for it. It is thinner, how[illegible] [illegible] caseous masses float about in it, and under the microscope it consists simply of molecular fat, without a definite pus-corpuscle anywhere. Abscesses formed in this way tend slowly to increase in size until at length they approach the surface. Their walls are lined with granulation-tissue, pale, insufficiently supplied with vessels, and containing myriads of tubercle-bacilli, and here and there small caseous masses, softening to add to the fluid. Outside this, and sometimes projecting so as to form septa in the interior, are the larger vessels, sheets of fascia, and dense fibrous structures that resist invasion. Growth takes place by the development of tubercles in the walls, following the easiest route, until at length somewhere the subcutaneous cellular tissue is reached. The skin at first separates, unaltered, from the deep fascia, and is lifted up so as to form a soft, fluctuating swelling, perfectly white and natural in texture. After a time, however, it shares the same fate; the bacilli invade it from beneath, tubercles form in its deeper layers, the surface becomes reddened, and at length the abscess breaks, leaving a long, sinuous track, winding in all directions from the original starting point, and lined with a layer of tubercular granulations mixed with caseous *debris*.

Obsolescence may occur even when the skin has been reached, and the abscess extends from the dorsal spine to the thigh; the fluid disappears, the tubercle bacilli cease to grow, the caseous *debris* becomes more and more inspissated, and at length forms a dense, solid mass, which slowly undergoes *cretification* and remains encapsuled in fibrous tissue for the rest of life. In children this is not uncommon, as tubercular disease of joints is in them distinctly a disease of a certain period.

In other cases *extension* takes place along the lymphatics. The neighboring glands enlarge, typical miliary tubercles make their appearance in the interior, forming foci, which, as elsewhere, spread by the margin while they decay in the centre. The capsule, formed of dense fibrous tissue, becomes thickened from the tension, and resists for a great length of time, but at last either it gives way, so that the caseous liquid spreads into the loose cellular tissue round and infects it, or suppuration occurs (periadenitis), and when the abscess bursts or is opened a caseous gland is found lying at the bottom, or adherent to one side, covered over with granulations. Before this, however, the mischief, as a rule, has spread to the [illegible] glands and formed a chain of which it is impossible to find the end.

[illegible] may take place through the blood-vessels, and, accord-

ing to the part of the circulation involved, acute miliary tuberculosis may develop in one or every organ in the body. In tuberculous disease of the kidney, for example, it may be limited to the lungs. When this occurs, the constitutional disturbance is generally so severe that the result proves fatal before the tubercles have attained any size or undergone more than incipient degeneration.

**Results.**—So long as the tuberculosis is local, recovery may be complete, with the exception that the portion of tissue infected is lost, whether it is removed by operation or undergoes caseation and degeneration with the products of the inflammation. This may take place even when the lymphatic glands are involved. The tuberculous predisposition appears in many cases to be of limited duration. Scrofulous scars are left in the neck; Pott's disease causes permanent deformity, or hip-disease leaves a limb shortened, distorted, and wasted; but as the period of growth ceases and the lymphatic glands and the ends of the bones lose the functional activity which characterizes them in youth the tubercular process sometimes ceases too, and cicatrices, which remain healthy through the rest of life, are left to show the mischief that has taken place. The tissues round recover sufficiently to throw out vascular granulation-tissue, and this becomes organized.

Death may occur either as a direct result of the tubercular process, dissemination taking place and proving fatal from the fever that accompanies it, or from a vital part, such as the brain, being involved; or as an indirect consequence due to the hectic, exhaustion, amyloid disease, etc., that follow on suppuration in connection with caseous foci.

**Treatment.**—1. *Local.*—Where it is practicable, there is no doubt that the seat of infection should be removed. If this cannot be done, an attempt may be made to check the further progress by the use of germicides, of which, perhaps, iodoform is the most to be trusted.

On the other hand, when the situation or the extent of the growth precludes this, all that can be done is to place the tissues in the best possible position for dealing with the germs themselves, and protect them from every other injurious influence. Fortunately, age is often of great assistance in this; it seems as if, sometimes, about puberty the susceptibility suddenly ceased, the tissues gained the upper hand, and repair commenced at once.

2. *Constitutional.*—Fresh air; if possible, sea air; but an equable temperature, not too moist, and especially free from cold winds. A moderate degree of warmth suits some; a cold, dry climate agrees better with others, but no general rules can be laid down for this. A thoroughly nutritious diet, with cod-liver oil, iron, and other tonics, is equally important. Stimulants are not required by the disease, although often they materially assist the digestion. The clothing should be light, but warm. A fair amount of exercise should be taken, and, in short, the conditions of existence should be, as far as possible, ideal.

## SYPHILIS.

Syphilis is an infective disease, due in all probability to the action of a specific organism. Its course, its power of indefinite multiplication in the body, and the fact, not only that it is contagious, but that it can only be propagated by contact, mediate or immediate, are sufficient proof; but it must be remembered that, in spite of the number of those who have tried, no one has yet succeeded in proving the existence of such a thing to the satisfaction of the rest.

In many respects syphilis differs considerably from the specific infective diseases already described. In the first place, although it commences acutely, its course is chronic and persistent. Wherever the inoculation takes place the immediate effect is local; then the lymphatics become involved, and very shortly the poison is distributed through the whole body by the blood-vessels; but after this stage is past it remains in the tissues, either latent altogether or with very slight evidence of its existence, and perhaps suddenly, after many years, breaks out again. Then it is not only propagated by direct infection to other individuals, but it is

hereditary; the poison can be transmitted through the ova and spermatozoa, so that characteristic lesions make their appearance in the child before or shortly after birth; and this transmissibility to the embryo is retained long after the power of infection by direct contact is lost. Further, while other specific germs cause, for the most part, some one definite form of inflammation, which, though it may be modified by locality, is yet characteristic of the cause, syphilis does not limit itself in this way. There is, it is true, a characteristic lesion, but it is also true that there is no form of inflammation which is not imitated, and imitated sometimes so closely that the diagnosis can only be made by the result of treatment. It must be acknowledged, therefore, that if the microbic origin of the disease is considered proved, there is yet a great deal that requires further elucidation.

The difficulty is not lessened by the fact that syphilis, or at least its initial lesion, is often complicated by the presence of another trouble, known as chancroid, in distinction from the true form of chancre; and it is still, to some extent, a matter of discussion what relation these two bear to each other.

### Chancroid or Soft Chancre.

A soft chancre, or chancroid, is a sore developed upon the genitals as a resul of contagion, and is distinguished from the hard or true chancre partly by th absence of induration, but chiefly (as this is only relative) by the fact that it i seldom followed by constitutional symptoms, and that the period of incubation i much shorter; the one is always under a week and generally under three days the other is always more than three weeks and is often as much as five.

Soft chancre is never met with except upon the genitals, and is probably du to infection from retained and decomposing purulent discharge. The intensel irritating character this possesses may be judged of from the fact that soft chancr occurring on a mucous surface is almost sure to infect the opposite side, and if th secretion is pent up, as in the case of phimosis, is almost certain to becom phagedænic. No specific germ has been proved in connection with it. It can b inoculated times without number without conferring the least degree of immunity It is never followed by any other result than those which are so common after a foul and sloughing sores on parts that are never kept at rest, and constitutiona treatment is of little or no avail for it. There is a popular impression that certai people are peculiarly liable to it, which may reasonably be accounted for by loca conditions; it does not appear to be dependent upon syphilis, but it may be ver closely imitated by a true syphilitic chancre on a person who has already suffere from that disease, and who has not yet passed through the period of immunity tha one attack confers. Under these circumstances, if there is a second infection, th character of the primary sore is often very much modified, both as regards perio of incubation and amount of induration; and although it is a true infecting sor it may present the appearance of an ordinary chancroid. In women, in whor the hardness is often slight and sometimes wanting altogether, the difficulty especially great.

**Symptoms and Cause.**—The favorite situation is on the mucous surfac of the prepuce, or just behind the corona. A small red papule is the first sign by the third or fourth day this has become a pustule with a bright areola, and i twenty-four hours more it breaks, leaving a sore with angry base and edges. I some few cases this heals without any further ulceration; probably the infectio has never really penetrated into the submucous tissue. More frequently it con tinues to spread, the edges are sharply cut, perhaps undermined; round them is bright red rim of inflammation; the base is grayish or yellow, covered with slough; and the whole thickness of the mucous membrane is destroyed. Th sore is usually circular in shape and very tender. On the glans it may be perfectl soft, without sign of induration; but when it is upon the skin the base is ofte infiltrated to such an extent that it is nearly as hard as a true infecting chancr The margin, however, is different; in a soft sore the edge of the induration

ill-defined; it shades off imperceptibly into the healthy tissues around, and no limit can be made out, but, at the same time, it must be recollected that this is equally true of a hard chancre when it is inflamed; and that, owing to the extreme mobility of the skin upon the penis, any sore with a hardened base felt in the longitudinal direction and lifted up from the tissues beneath appears exceedingly well-defined. The secretion, at first, is thin and watery, with a few shreds and sloughs detached from the surface floating in it; later, when granulations form, it consists of ordinary pus, such as comes from any other sore.

If, owing to phimosis or balanitis, the secretion is retained under the prepuce, so that it decomposes, the ulceration is very much more severe, and may become phagedænic. The sore increases in all directions; the opposite surface of the prepuce is attacked; the skin on the outside is reddened; the whole of the end of the penis becomes swollen; and if relief is not speedily given, the skin sloughs, ulcerating through from beneath, and the end of the glans protrudes through a ragged opening on the dorsum. In the worst cases the destruction is even greater; the whole of the skin covering the end may perish, the glans be in great measure destroyed, and the urethra laid open.

The inguinal glands, that lie parallel to Poupart's ligament, are always more or less inflamed. In the slighter cases they are simply enlarged, swollen, and tender; their outline is indistinct, and if several on the same side are attacked, they cannot be isolated from each other. In the more severe ones suppuration occurs, generally commencing in the loose, cellular tissue around (periadenitis), so that when the bubo is opened the glands are seen projecting into the cavity, surrounded and bathed with pus. Sometimes, however, it appears to begin in the interior of the gland, and occasionally in both places at the same time. It is said that when this happens the pus from the interior of the gland is infective, while that from the tissues around is not. Phagedænic and serpiginous buboes are met with exceptionally in very severe cases of syphilis combined with soft sores, or when the patient's health is utterly broken down from want and exposure. No constitutional symptoms ever follow a true soft sore, and the inflammation of the lymphatic gland is merely due to the absorption of pyogenic organisms, assisted by the retention of decomposing secretion or other injurious influences.*

**Diagnosis.**—Herpes preputialis presents the greatest difficulty. This very peculiar affection may occur after every act of connection; it has even been known to follow nocturnal emissions; and though it may be more severe and more common in those who have suffered from syphilis, it is certainly met with in those who are perfectly free from the disease. If there is only one vesicle, or two perhaps, and the case is not seen until the epidermis is broken, there is no means of forming a diagnosis.

If, owing to the enlargement and swelling of the prepuce, the existence of a sore is doubtful, circumcision must be performed; and the need for this increases with the amount of redness and inflammation. The co-existence of syphilitic infection cannot be affirmed or excluded until the period of incubation (six weeks at least) is past.

**Treatment.**—Local chancre spreads because of the poisonous character of its discharge. A single application of the acid nitrate of mercury leaves, as soon as the slough separates, a perfectly healthy granulating surface. So severe a measure as this, however, is rarely necessary unless the sore is phagedænic and it is imperative to stop the progress at once. Ordinarily speaking, if the surface is well cleansed and dried, and then dusted over with iodoform, night and morning, the character of the secretion changes immediately. Phagedæna should be treated, as already mentioned, by the use of prolonged warm baths. Mercury is not required unless the healing of the chancre is unaccountably delayed, or there is something else suggestive of syphilis.

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[* The opinion of our author on this point is met by equally positive statements *per contra*.]

### Acquired Syphilis.

The period of incubation varies from three to seven weeks; at the end of that time certain local changes make their appearance (the hard or infecting chancre); a few days later the lymphatics are involved, and then very quickly there is evidence that the poison has gained access to the blood. Much later, after an interval of months and years, local phenomena appear again, due in all probability to the action of the poison latent in the tissues. These stages, of course, overlap each other, and no hard and fast line can be drawn between them; thus the lymphatic tissues and the blood are always involved before the chancre has disappeared (indeed, there is evidence to show that they are affected almost from the first, although there is no manifestation of it for some time, for excision of the point of inoculation after the third or fourth day is of little or no use) and local changes may take place while the general ones are still at their height; but the distinction between the three is convenient, and they are recognized as primary (or local), secondary (in which the lymphatic glands and the blood are involved), and tertiary, or local again.

1. **The Primary Symptoms.**—Inoculation may take place anywhere, through a wound or superficial abrasion, or possibly in the case of mucous membranes even without this, if the poison is allowed to remain upon the surface for any length of time. The retropreputial fold is the commonest situation in men, the nymphæ in women; but chancres are met with upon the skin of the penis, upon any part of the female genitals, and practically on every part of the body; the lips not uncommonly; the tongue and even the tonsils; the conjunctiva; the bridge of the nose; the nipple (especially in wet nurses who are infected by children suffering from hereditary syphilis); the angle of the finger-nails, and the web of the fingers.

In a genuine inoculation no change is witnessed for from three to six weeks; a transient redness has been described during the first few days, but it is not often noticed. Then the part becomes dusky, slightly elevated, smooth and glazed. In the ordinary situations it is not sensitive, and the patient may be in total ignorance of its existence, but I have known some instances in which the pain was very severe, especially when it occurred upon the fingers. The characteristic feature is the induration; the seat of inoculation is not only hard, but the edges of the hardness are sharply defined. If pinched up, it appears like a piece of cartilage let into the skin. The exudation in the meshes of the cellular tissue is so abundant that a certain small but well-defined area becomes practically solid.

It must be admitted, however, that this induration varies so greatly in different localities and under different conditions, that, although its presence when it is characteristic may be absolutely relied upon, its absence is not a proof of non-infection. On the glans, where the mucous membrane is thin and closely adherent to the tissues beneath, it is very superficial. In the retropreputial fold it is often so marked that the diagnosis can be made from merely seeing the way in which the hardened and thickened prepuce rolls back from the sulcus, and stands up like a collar round it. In women it is often not to be discovered at all, and when the chancre occurs on other parts of the body—the lips or fingers, for example—it varies within very wide limits. No doubt this is due in some measure to the anatomy of the part inoculated—the presence, for instance, of loose cellular-tissue beneath—and the depth to which the inoculation is carried in each case; but the extent and duration are so variable that there must be other considerations as well. There is no relation of any kind between the size, hardness or number of the infecting sores and the severity of the constitutional symptoms. Several sores may be present at the same time, from multiple inoculation, but the worst cases often follow a single one that is scarcely noticed.

The appearance of a hard chancre is very variable; the skin that covers it may remain unbroken, so that there is neither secretion nor ulcer, but merely a

slightly raised and hardened spot, pigmented for a time. This, however, is exceptional. More frequently the epidermis scales off, exposing the subjacent tissue, which undergoes necrosis and melts away; but whether this is due to the effect of the poison, or simply to pressure, is not known. When this happens it leaves a superficial sore, which may or may not suppurate; in many cases the only discharge is a thin watery serum with a few epithelial scales, or a little tissue debris without true pus from first to last. If a soft chancre is present already, the appearance and the discharge are naturally dependent upon this; the only change at the end of the incubation period is a sudden hardening at the base. Chancres in the finger usually take the form of a patch of small and rather florid granulations, with little discharge, and without any evidence of cicatrization at the edge. The margin is raised above the level of the skin, and appears steep and thick from the exudation it contains. On the lips it is much the same, only in some cases the infiltration at the base and edges is so great that it is slightly cup-shaped.

The duration of the hardening and rapidity of cicatrization are no less variable. If untreated, the sore is said to last six or nine months, and leave a cicatrix depressed according to the amount of tissue lost. Very often, however, under the influence of mercury it vanishes altogether in a few weeks, and it is exceptional for it to continue more than three months. Its disappearance is not complete until all hardness is gone from the cicatrix; sometimes when a hard sore complicates a soft one, healing takes place very soon after commencing mercurial treatment; but in spite of this the induration of the base persists for a considerable period.

When the infection is mixed, the extent of the suppuration is sometimes profuse, but there is no evidence that it is ever sufficient to prevent the development of constitutional symptoms. The same may be said of phagedæna. Relapsing chancres are occasionally met with. It is not uncommon to find, if the treatment is interrupted too soon, that the induration, which was beginning to subside, extends again; but, independently of this, true relapses occur, sometimes a year afterward, the seat of the original infection becoming indurated again and slowly subsiding under treatment without there having been a sign of its existence in the meanwhile; and this may happen more than once.

2. **The Secondary Symptoms.**—The secondary stage includes the infection of the lymphatic glands, and the general symptoms that follow the entry of the poison into the circulation.

*Glandular enlargement* usually shows itself ten days or a fortnight after the appearance of the primary sore. The local ones are affected first, the inguinal, for example, when the chancre is on the penis, the submaxillary when it is on the lip; but it never remains limited to them. From the beginning the enlargement is multiple, and it soon becomes general, not as in the case of the uncomplicated soft chancre, limited to one locality and often to one gland. The character of the swelling is also quite different. Unless the infecting chancre is inflamed, or a soft one is present as well, there is little or no infiltration of the periglandular tissue; the enlargement is confined to the glands themselves; they swell up, become hard, and slightly tender, but they remain perfectly isolated and distinct, and they are as freely movable as they are in health. The inflammation is specific, not simply due to absorption of septic or suppurative products.

Whether suppuration occurs in the first set of glands involved depends entirely upon the character of the sore; if it is foul and sloughing, the pyogenic organisms will, in all probability, gain access through the lymphatics, and, finding a genial soil, excite suppuration, whether syphilis is present or not, and without having any influence upon it. The same thing is true of phagedæna: an ulcer left by a suppurating bubo, occasionally under the combined effect of syphilis, a broken-down constitution and other injurious influences, becomes itself phagedænic; but at the present day it is decidedly rare. The glands once removed, too far distant to be affected by local causes of this character, sometimes attain a very considerable size, but never form abscesses. As a rule the enlargement subsides quickly at

first, but evidence of it can usually be found so long as the secondary period lasts and sometimes long afterward.

As soon as the poison gains full access to the blood, it causes a train of symptoms which may be compared with those that accompany the acute exanthemata and other specific diseases.

There is a slight but fairly constant degree of *fever*. The temperature rises regularly of an evening, although of a morning it may scarcely be above normal. In exceptional cases it is very severe, especially when the eruption that accompanies it is varioloid, or there is considerable glandular enlargement, and it may last for several weeks.

*Anæmia and emaciation* are always present, and sometimes very marked. The number of red blood-corpuscles is diminished, and, it is said, the proportion of hæmoglobin they contain. With this there is usually general *malaise;* the appetite is lost, there is great mental depression, and, in short, there are all the signs of mild blood-poisoning.

At the same time, or even before this, a *rash* makes its appearance upon the skin and the mucous membranes. This varies very greatly in its character and severity. In the mildest cases there are merely a few round, roseolous spots upon the chest, abdomen, and flexor surfaces of the arms, lasting some days, then dying away with a scarcely perceptible scurfiness of the integument and leaving a faint yellow stain for a week or two. More frequently, in addition to the hyperæmia there is a certain amount of exudation, the roseola spots are raised, and followed by definite desquamation, or little papules and tubercles are formed. When the attack is more severe, the inflammatory changes may be very considerable, and stasis and actual extravasation take place as well, so that deep stains are left for months. The eruption sometimes resembles psoriasis, although the distribution is not the same and the patches are always small and not covered with silvery scales; it frequently imitates lichen, and (especially on the shoulders and back of the neck) acne; in some cases it resemble variola so closely that patients suffering from syphilis every now and then find their way to smallpox hospitals, particularly as this form is often accompanied by high fever; and toward the end, when the first eruption is dying out, rupia sometimes occurs, a number of papules running together, ulcerating, and forming on the surface a great conical, limpit-shaped crust of dried-up discharge, which keeps enlarging in height and circumference, just like a shell, by addition to the margin as the destruction spreads.

Where the skin is moist and in contact with other surfaces, these spots are modified into mucous patches of flat *condylomata*. The epidermis is macerated away; the papillæ, already inflamed, are exposed and irritated more and more, and at length raised patches are formed, something like a mucous surface (whence the name), moist, pinkish-red, and smooth. They are met with in every part, but the favorite places are between the nates, inside the labia, under the penis, between it and the scrotum, in the axillæ, and behind the ears.

The mucous membranes are similarly affected. The interior of the mouth, the tongue, the soft palate, and the larynx are covered with an eruption identical with that upon the skin. The epithelium is bluish-white from maceration; round this is a bright red rim, gradually fading away, and in the centre there is often a small superficial abrasion. On the tonsil this gives the appearance of a deeply-punched-out ulcer; on the soft palate it usually occurs just at the margin on each side of the uvula, the rest of the surface being a dusky, brownish-red; and on the tongue it forms a smooth, bald patch. Sometimes, when the eruption is papular, raised mucous plaques are produced instead.

At the angles of the mouth, nose, and anus, and in the clefts between the toes, the eruption assumes a slightly different form. It is just as if a mucous patch had formed in the angle of junction, red, moist, and, differing in this respect from those that occur elsewhere, intensely painful. This, of course, is due

exudation. In those that are a little more severe there is enough to cause desquamation, the epidermis either drying up in scales or becoming macerated, according to its situation. When the amount of exudation is considerable, stasis and perhaps extravasation occur (as in the tubercular syphilides); some of the tissues perish, and a deep brown, depressed stain is left, with an altered appearance of the surface, owing to the regularity of the papillæ having been destroyed. In the worst cases, when pyogenic organisms as well gain access to the part, as in rupia and phagedæna, the loss of tissue may be very extensive, causing cicatrices that cannot be mistaken. The intensity of the poison, the constitution of the patient, the anatomy of the part, and the conditions under which it is placed all take a share in the result.

The characteristic features of a secondary syphilitic eruption are its *symmetry* (this is often perfect, spot for spot, both in time and place), its *color* (usually described as resembling that of lean ham, and in most cases leaving stains behind it), and especially its *polymorphism*. True psoriasis is psoriasis wherever it occurs and, except perhaps in the direction of lichen, never really resembles anything else. Lupus acts in the same way, and so with variola and other specific affections. Syphilis, on the other hand, may, and usually does, present a fairly good imitation of half a dozen of these at once. Where the skin is thin, as on the chest and arms, there are roseolous spots; a scaly eruption is more frequent where it is thicker; papules are common round the roots of the hair; acne spots may be found on the shoulders; little dark-colored tubercles occur upon the legs; one or two rupia spots may be present at the same time, and not unfrequently the ala of the nose is rapidly destroyed by a phagedænic imitation of lupus. All these are often present together, or, what happens still more frequently, the milder varieties come out first, generally all over the body; many of the spots disappear, leaving stains behind them; others steadily get worse, the amount of exudation continuing to increase, and then they become complicated by suppuration. So that in this way tubercular syphilides, the varioloid form, and rupia are scattered among psoriasis patches, acne spots, and the stains of past roseola. The pigmentation after secondary syphilis is suggestive, but nothing more, as deep stains are not unfrequently left by true psoriasis, especially upon the legs and back. The most characteristic is that which is associated with rupia scars, where there is a dead-white tissue-paper cicatrix in the middle, and round it an irregular circle, often deeply stained.

Recurrent attacks of roseola are not at all uncommon, sometimes occurring with recurrent hardening of the primary sore. It does not follow either that the same part of the body is involved (it may be present on the hands in one attack and not in the other, for example), or that the eruption presents the same character.

The skin eruption, the anæmia, and the fever are very rarely absent, supposing secondary symptoms of any kind are present. In addition to these, there are other lesions which are frequent, but by no means universal, and which, though to a certain extent symmetrical (showing thereby their dependence upon the condition of the blood), are still distinctly local, and constitute, as it were, a transition to those later forms (tertiaries) in which the tissues only are concerned.

*Periostitis*, especially of the superficial portions of the compact bones (*e. g.*, the tibia, ulna, clavicle, and cranium), is one of the most common. It is always acute, very painful, and subsides readily under treatment, without leaving any thickening. Vague so-called rheumatic or *osteocopic pains*, occurring in the bones at night, are probably due to transient hyperæmia without exudation; and in some of the cases in which there is severe localized headache it is possible there is a similar affection of the dura mater.

*Synovitis* may occur, both in the tendon sheaths and joints, but it is more rare. *Alopecia* is not infrequent, the hair of the scalp often falling out in tufts, so that the appearance is most peculiar. It is never permanent. *Epididymitis* (as distinguished from the orchitis of later syphilis, in which the epididymis is often

involved) is occasionally met with. Recently I have seen two cases of secondary syphilitic *phlebitis*, in one of which, among other veins, some of those in the internal ear were affected, deafness, with many of the symptoms of Menière's disease, coming on quite suddenly. *Arteritis* is more common later on.

In other cases there is a great tendency to the production of papillomatous growths almost unattended with inflammation. These are known as *verrucæ or pointed condylomata;* they may form great dentritic masses when they grow from the genitals, or be merely simple papillæ somewhat enlarged, like those that are so frequently met with upon the dorsum of the tongue, far back in the middle line. No distinction can be drawn between them and the ordinary flat mucous patch with which they are often associated.

Finally, although the two eyes are rarely affected symmetrically in point of time, iritis must be placed among the occasional secondary symptoms. Later affections of the eye, choroiditis, for example, and neuroretinitis, are sometimes included as well.

**Duration of the Secondary Period.**—No definite limit can be assigned; there may be no symptoms at all; it may last a month, or it may be continued for a couple of years.

The symptoms are for the most part symmetrical, the earlier ones always so, because in all probability they are due to the effect of the virus upon the blood itself. Long before these have passed away, however, the tissues are involved as well, and then symmetrical lesions are mingled with the others; later still, when the blood infection has quite died out, in the so-called tertiary stage, these occur alone.

Secondary symptoms have a tendency to get well of themselves; the blood and the tissues may yield at first to the effect of the poison, but provided the patient is in fairly good health, and not exposed to influences of a too injurious character, the lesions subside again, even without treatment. Later in the tertiary period the tissues seem to lose this power and the morbid changes steadily grow worse and worse.

The blood and the discharges from the eruptions are inoculable during the secondary period. There is no authenticated case of the disease having been transmitted in this way from any tertiary affection. How long the power of infection by contact lasts is naturally uncertain; it may be a few months, but it is rarely more than two years. This disappearance from the blood is not due to any alteration in the blood itself—to the exhaustion, for example, of some substance necessary for the growth of the poison—for second attacks of syphilis are by no means uncommon, and it sometimes happens that a person becomes affected for the second time, and that the disease runs a scarcely modified course while tertiary symptoms are actually present. It is no less true that the virus remains the same, and is capable of regaining its vigor if the conditions are a little changed. Direct transmission to another individual may no longer be possible, but the ovum can be infected through the spermatozoa long after the secondary symptoms have subsided, and shortly after birth the child may become covered with an eruption of an intensely contagious character. Transplanted in this way to a fresh soil, the virus regains its vigor and multiplies again indefinitely, the period of incubation, before it manifests its influence, depending very largely upon the activity of the poison in the parent. The more recent the infection in the latter, the shorter the incubation in the embryo, and the more disastrous the results. It would seem, therefore, that the virus, when it leaves the blood and becomes imbedded in the tissues, may either remain latent for years (perhaps for life), or may at any time cause local inflammation of a progressive character, slowly infecting the structures around—tertiary symptoms, but that except under certain conditions (of which transmission to the embryo through the ova or spermatozoa is one), it has lost its power of inoculation.

Suppuration, like phagedæna, is an accident in syphilis which may occur in connection with secondary as well as tertiary lesions. That it is not seen more

frequently in the former is probably due to their transient character, and the small amount of exudation that accompanies them. Many of the slighter forms of secondary syphilitic affections, whether they involve the skin, the periosteum, or the iris, are probably merely attended with hyperæmia; in the more severe ones, however, especially those that occur rather later, the amount is often considerable; and then, especially if the lesion is near the skin or a mucous surface, suppuration and ulceration are very likely to follow. A syphilitic affection is not tertiary, because it leaves a scar. Rupia, which distinctly belongs to the late secondary manifestations, leaves perfectly typical cicatrices, which can be recognized throughout the rest of life, dead-white, circular, with a rim of pigment interrupted here and there, and as thin as tissue-paper, wrinkling like it when pressed together. The only condition that can be mistaken for it is the scarring left by splashes of molten metal.

### Tertiary Syphilis.

The tertiary period does not admit of exact definition any more than the others. It may begin within a few months of the primary affection, while the secondary symptoms are still present, or it may be postponed for years. There may be a period of complete immunity, during which the patient shows no sign of disease, or one form of lesion may succeed another without a break.

For convenience sake an intermediate stage is sometimes spoken of, during which the patient is subject to certain affections known as "reminders," iritis for example, choroiditis, orchitis, arteritis, and scaly eruptions upon the hands and feet; these are distinguished from the true secondary forms, upon the one hand, by their want of perfect symmetry, and from the tertiaries, upon the other, by their tendency to get well, more or less, of themselves; but the definition of these stages becomes difficult in proportion to their multiplication.

The history of acquired syphilis is a continuous one, although sometimes there are long breaks in it. At first the virus infects the tissues around, producing a hard chancre. Then it gains the lymphatics and involves the blood; during this stage it is inoculable, the lesions are symmetrical and tend to get well of themselves. Long before this has passed it has begun to affect the tissues too, at first simply leading to a transient hyperæmia; then, as the power of their resistance diminishes, causing a certain degree of exudation; and, finally, in the last stage (which when the vitality of the tissues is very low may begin almost at once), forming great masses of inflammatory granulation-tissue which slowly undergo caseation. There is no break anywhere in the pathological changes; they shade off imperceptibly one into the other; the distinctions are that, while the virus affects the blood it is inoculable, when it involves the tissues only it is not, though it may regain its power under peculiar conditions; and that after it has spread from the blood to the tissues, these lose the power of dealing with it unaided, so that the lesions continue to grow worse.

The histological changes in tertiary syphilis are identical with those that occur in the other form of chronic infective inflammation; the difference is in their distribution and course. Wherever the virus spreads it lowers the vitality of the tissues with which it comes in contact, or kills them; and at once those around begin to throw out granulation-tissue composed of leucocytes with epithelioid and giant cells (a few only) as in tubercle, and the other infective granulomata. The ultimate effect of the exudation and the effect it produces in different parts of the body depend upon its situation and amount. In some places it undergoes organization, becoming converted into dense, fibrous tissue or bone, as the case may be. This is most common where it is scattered throughout an organ, not collected in one spot, and is often partial, some being absorbed. In a measure, it may be regarded as a process of repair, but it often leads to the most disastrous consequences from the condensation it entails. In others, in which instead of being uniformly distributed it is collected into masses, caseation sets in as soon as

... degeneration arises from the effect of the virus ... due to the arteries being blocked by the ... known: in any case the change is not one ... Masses of this kind are known as *gummata*. ... soft, vascular granulation-tissue, and so ... the margin retains this character. As they increase in ... of a walnut or be larger still—a certain degree of ... following this, caseation. Three strata, therefore, ... a layer of still-growing inflammatory exudation, ... of least resistance, and therefore very irregular in ... organization; and in the centre, a caseous mass. ... proportion of these three is very variable; in many cases ...

... of tertiary syphilis are frequently complicated by ... organisms, which are practically of general dis- ... are unable to produce any effect so long as the tissues ... when there is disease, and hasten the process of ...

... to a deeply-buried caseous mass (in the tongue, for ... tissue) not unfrequently the whole of the infiltrated ... gangrenous from the intensity of the combined effect; ... membrane, as the case may be, gives way; a circular ... undermined and steeply-cut edges, and at the bottom is a ... slough. Similarly, if the infiltration is in the substance ... forms of ulceration follow. It is this mixture of organization ... separation and sloughing, while all the while the syphilitic ... exudation is continuing to spread at the margin, that causes the ... variety of the lesions characteristic of the tertiary period.

**Intermediate Symptoms.**—The symptoms of the secondary stage are ... and tend to get well. After they have subsided there is often a period of ... immunity; but in many cases, if inquiry is made, it will be found that ... all the symptoms that are really secondary have disappeared, there have been ... attacks somewhat the same in character, but more chronic in their course ... much less severe. Their distribution is not general, and they do not occur ... indiscriminately, only where there is some other source of irritation: there is a ... greater amount of exudation than in most of the secondary symptoms, and though ... they occasionally get well of themselves, there is, on the whole, a decided ... tendency for them to spread. In other words, they form a transition to the true ... tertiary ones.

The eruption that occurs on the palms of the hands and the soles of the feet ... an example. In the secondary stage a number of separate spots form rapidly, ... become scaly, and disappear again in a week or two. Later, if they recur and ... naturally this is more common on the right side than the left, their course is more ... slow, they are fewer in number, there is a greater amount of exudation, the scales ... are less distinct, and they have a tendency to spread at the margins. In the true ... tertiary period, if an eruption breaks out in this locality it is usually almost ... circular, very chronic, and extends in widening circles or parts of circles. In the ... centre, at the spot where it began, it gradually dies away, leaving a smooth, more ... or less shiny and pigmented surface; there is no distinct scarring, merely an ... alteration in the texture of the skin; at the margins it steadily advances, and if ... at any time one spot becomes isolated—if, for example, the whole crop is cleared ... off in one little area—this forms the focus for a fresh ring.

The same thing occurs at the angles of the mouth and the anus to a less ... extent at the ... of the genitals again and again, leaving radial scars ... and fissures, bridged with a smooth, pale, glistening surface. They are not ... unlike the sores ... of the same nature, but are more ... chronic; there ... healing at the base, there tend to spread

in circles, or parts of circles, on to the chin and lips, and they leave white linear cicatrices when they heal.

The tongue shows the same, especially with smokers. White patches return again and again, until at length all the papillæ are leveled up by the exudation, and a smooth, bare, white spot is left, surrounded by a still extending infiltration. In other parts of the body there are circular cutaneous eruptions, or patches closely resembling the lighter forms of lupus, especially those that scarcely leave a scar; or sometimes affections of a still more serious character—iritis, arteritis, orchitis, periostitis, etc.

In many cases, especially when treatment is thoroughly carried out, these, year by year, grow milder and milder, until at length they cease altogether. On the other hand, it sometimes happens that, after a variable and most deceptive period of quiescence, true tertiary affections follow, steadily progressive in their character, and inevitably, if not thoroughly treated, passing on from bad to worse.

**Tertiary Symptoms.**—Two chief varieties can be distinguished, although it is impossible to draw a definite line between them. The one is characterized by, at first, an enormous local collection of inflammatory deposit—a gumma, which, according to the conditions under which it is placed, undergoes caseation, absorption, or sloughing. The other, which is not so striking, leads at once to organization and condensation without any preliminary stage.

*The Skin.*—Nodular and tubercular eruptions of various degrees of severity are common upon the back of the neck and shoulders, round the scalp, and in the region of the nose and lips. In the last-mentioned locality they often resemble lupus very closely, but the little elevations have not the gelatinous appearance characteristic of true lupus, the course is more rapid, and if there is a cicatrix it is firm and white, not thin and red. Moreover, it rarely happens that all the spots present the same characters. The milder forms subside without leaving any definite mark other than pigmentation; those that are more severe, in which the amount of exudation is greater and the natural texture to some extent absorbed, cause a peculiar flattened and smoothed appearance of the skin; the worst, in which suppuration occurs as well (this is especially common upon the legs), leave definite cicatrices that vary in depth according to the amount of the deposit. Wherever the eruption occurs, it is always serpiginous, healing in the centre, constantly creeping on at the margin, so as to form rings or parts of rings, often intersecting, as when one has advanced in one direction and crossed another, and the cicatrices naturally follow the same course. It is common to find a pigmented spot from which the eruption started; then, a thin cicatrix, scarcely producing a definite alteration in the skin; beyond this, typical scar-tissue, white, with patches of dark pigment here and there, and on the extreme margin a ring of ulcers and nodules; the eruption starts in the centre and gradually increases in depth and width the longer it lasts.

*The Cellular Tissue.*—The subcutaneous and submucous tissues are especially liable to be the seat of gummata. A smooth, rounded swelling forms rather rapidly and without much pain, the skin over it becomes red and adherent, then it gives way, retracts as only skin can retract when it is separated from its deep attachments, and leaves a deep, circular, punched-out hole, with, perhaps at the bottom, a slough formed from the cellular tissue. Round the knee-joint is a very favorite locality, and, combined with the skin eruption, of which they are merely a deeper variety, these gummata lead to characteristic cicatrization. Not unfrequently they extend some distance down the leg, and it has been said, with as much truth as is usual in universal statements, that every ulcer that begins between the middle of the leg and the knee is due to syphilis. Other joints are not so often attacked, but wherever there are bursæ, gummata and serpiginous eruptions upon the skin are always liable to occur, partly because of the amount of loose cellular tissue, partly from the way in which structures of this kind are exposed to injury. Submucous gummata are of common occurrence in the tongue,

soft palate, and pharynx, and possibly some cases of stenosis of the trachea, œsophagus, and rectum originate in this way.

In addition to these localities, gummata may occur in any of the soft tissues; in the synovial and peri-synovial tissues of joints, simulating strumous disease; in the membranes of the brain and spinal cord, causing epilepsy, convulsions, paralysis (especially of the oculo-motor nerves), and paraplegia; in the walls of the arteries, leading to aneurism, thrombosis, and even rupture; in all the viscera, but especially the testes, liver, and lungs, and particularly in the substance of the muscles. Wherever they form, they give rise to rapidly-growing swellings, attended with a considerable degree of inflammation and affecting all the structures around. Suppuration is chiefly liable to occur in the superficial ones and those that are exposed to injury.

The effect produced by gummatous infiltration of the tissues does not disappear with its absorption. Not only is there at the time a certain amount of actual destruction which can never be repaired, but even when all the syphilitic exudation is removed without there having been a trace of pus, a dense, hard, and contracting cicatrix is left, which in certain situations leads to very serious results. A typical example of this occurs in the liver, in the middle of which it is not uncommon to find a deep, star-like mass of cicatricial tissue, radiating in all directions; and even worse consequences may follow when, for example, the dura mater is involved, or a stricture is developed in the trachea or œsophagus.

*The Bones and the Periosteum.*—In the secondary stage, when the symptoms are acute, the vascular layer of the periosteum is the part chiefly affected; if the attack is slight, there is merely hyperæmia; where more severe, exudation takes place as well, stretching the fibrous layer and forming an intensely painful node, generally on the subcutaneous surface of one of the long bones; in the tertiary stage, when the disease is chronic, the bone itself is the part involved. In this syphilis merely follows the ordinary rule; acute inflammation cannot occur in compact bone; time is needed for the necessary histological changes, the softening and absorption of the solid parts, and the expansion of the Haversian systems.

The vault of the skull is one of the favorite situations. A swelling slowly forms under the scalp and gradually increases until at length the soft tissues over it become inflamed from the tension to which they are subjected. It is painful, especially at night, but not in the same way as a secondary node; and it is very tender on pressure. Then it breaks down, suppuration follows, the skin gives way, and the bone beneath is exposed, rough, carious, and often blackened already. The syphilitic exudation penetrates into all the Haversian canals, eats away their walls until the bone becomes porous, and then undergoes caseation, the bony trabeculæ still left perishing at the same time, from their blood-supply being cut off. Even without suppuration extensive areas on the vault of the skull may be destroyed in this way. If pyogenic organisms gain access too, the inflammation is much more severe; necrosis occurs as well; and huge plates, involving the whole thickness, may perish from the frontal or parietal bones, leaving the dura mater exposed beneath. Typical, deeply depressed cicatrices in the frontal region, are sometimes seen, caused in this way; and the pulsation of the brain can be felt through them, for no new bone is ever formed.

Similar changes are met with in connection with other bones. Gummata of the hard palate are exceedingly common, leading to perforation, always in the middle line. Sometimes they are limited to the mouth; more frequently they involve the septum, turbinate bones, and even the nasal bones, so that a huge cavity is left filled with necrosed fragments and decomposing pus, and shut off almost altogether from the pharynx by the adhesion of the soft palate to the posterior wall. In the neighborhood of joints it leads to still greater destruction; every part of the articulation may be affected, the skin may be reddened, infiltrated, and covered with ulcers; the subcutaneous and perisynovial tissues filled with exudation; and the ends of the bones and the periosteum swollen, softened,

and eaten away to such an extent that recovery seems almost hopeless. Sometimes gummata form in the medullary canal of one of the long bones, leading to so-called spontaneous fracture. More frequently, especially in the case of the lower extremity, the exudation is, in part at least, diffuse, and dense, hard masses of new bone are formed; or the two are combined, ulceration and necrosis occurring in one spot, and hypertrophy over the rest. Symmetrical osseous nodes of immense size are not infrequent on the inner surface of the frontal bone; but, although the diploë may completely disappear, they rarely extend beyond the mid-parietal region, and are never seen upon the outside.

*The cartilages of the larynx*, especially the epiglottis, are frequently attacked. In some cases the ulceration begins on the surface and extends into the deeper structures; in others, a gumma forms on or around them in connection with the perichondrium; suppuration sets in, and when the mucous membrane gives way the cartilage is laid bare, dead and already partially separated. Very serious stenosis of the larynx may be caused by the cicatrization that results. Similar changes are of common occurrence upon the costal cartilages, and even more frequent upon the sternum.

Tertiary syphilis, when it affects the *nervous system*, does not so often give rise to the formation of gummata (although these may occur in the membranes round the brain and spinal cord and lead to very serious changes) as to a peculiar form of sclerosis, which tends to spread indefinitely. It is probable that it is always preceded by effusion, but this rarely attracts attention before the consequent atrophy has begun; wherever it occurs it is characterized by a steady tendency to progress and invade the structures round, as surely as a serpiginous eruption in the skin, or a neglected gumma in a muscle. Unfortunately, it does not respond so easily to treatment.

The symptoms to which it gives rise naturally present the greatest possible variety. The cranial nerves may be involved, especially those connected with the eye. Amaurosis may occur from atrophy of the optic nerve; ophthalmoplegia externa from paralysis of one or more of the nerves that control the movements; or this may be combined with paralysis of accommodation as well, so that the pupil is dilated, the eyelid dropped, and the eyeball fixed, according to the nerves involved. The fifth and the facial suffer sometimes as well. General paralysis may follow from the same cause; probable locomotor ataxy with its multitude of complications is often occasioned by it; epilepsy and insanity certainly are, and, in short, there is scarcely a trouble due to chronic inflammation of the brain or spinal cord, or the nerves issuing from them, that cannot sometimes be traced back to the influence of the syphilitic virus. That affections of this kind are always due to syphilis is another matter altogether; when they are steadily progressive it is very probable they are, the virus slowly but surely extending its field in the nervous system as upon the skin; but it is only one of the causes, even if it is the commonest; and the particular locality and the special kind of lesion are probably always determined by other predisposing agencies. Unhappily, although, if treatment is commenced in time, the progress of the disease may generally be checked, its effects, when it has once declared itself, are permanent.

**Prognosis.**—Syphilis, even if it is not treated, gradually tends to die out in the majority of cases; out of ninety-three watched by Diday, only four suffered from early tertiary symptoms, though twenty-nine had eruptions of various kinds, periostitis, iritis, and other severe secondary affections for upward of two years. At the present day, however, the course of the disease is always so modified by treatment that such observations are of little value. Like measles, smallpox, and other specific diseases, it is said that, when carried to a fresh country, it becomes intensely virulent. On the other hand, in other parts of the world—in Iceland, for example,—serious effects are seldom seen. Very much must depend upon the constitution of the individual; cases are sometimes met with in which, in spite of everything that can be done, the disease steadily progresses from bad to worse, the most disastrous tertiary symptoms making their appearance early in its course.

As a rule, in these there is a history of long-continued intemperance, or of Bright's disease; and very often the patient is already past middle life; but they are occasionally met with in the young, and in those who are in good circumstances. As might be supposed, if there is any tendency to phthisis the prognosis is distinctly more grave, pulmonary symptoms not infrequently making their appearance during the cachexia of the secondary stage, and running a rapid course. Syphilis is rarely directly fatal, unless the cerebral arteries are affected.

In the vast majority of cases, if treatment is commenced at once, and carried out thoroughly, and if the patient can and will give up a sufficient length of time to it, secondary symptoms are either avoided altogether, or occur in a very mild form. It is, however, of the utmost importance to begin at once, as soon as there is a suspicion of the disease; if the poison is once allowed to gain a settlement in the tissues, if, that is to say, local symptoms (other than the primary chancre) have made their appearance, the prospect of permanent cure becomes much more doubtful. The reputation enjoyed by some of the foreign bath resorts is due partly to the change in living, but chiefly to the fact that the treatment of the disease is made the first consideration there, everything else being subordinated to it.

One attack confers only a limited degree of immunity. Auto-inoculation from a primary chancre merely leads to the formation of a papule, unless the sore is inflamed or suppurating. After the secondary period has subsided, a fresh infection generally causes the development of a modified chancre, which is not followed by any further symptoms; but this rule is by no means invariable. I have known several instances in which second attacks of syphilis have occurred within three years, and more than one in which local cutaneous eruptions were present at the time of the second infection. In some of the cases the second attack was milder than the first; in others it appeared to be entirely uninfluenced by it, running a typical course; in one it was distinctly much more severe, and was followed by tertiaries.

During the primary and secondary stages, the blood and the secretions from the eruptions (especially condylomata) are intensely infective, and the greatest care is required to prevent mediate contagion; many cases have arisen from smoking a pipe that has been used by a syphilitic person. The normal secretions, however, seem to be free from it. In the tertiary stage, the virulence appears to die out, so far as direct inoculation is concerned.

With regard to *hereditary transmission* the facts are not so clear, and a distinction must be drawn between the likelihood of infection and the severity of the symptoms. It is well known that of twins the one may suffer severely, the other hardly at all; and it is said that one may escape altogether.

Where the treatment of the parents is neglected altogether, or what is nearly equally bad, merely carried out in a casual way from time to time, the ordinary rule is for the earlier children to suffer, the later ones to remain free. Not infrequently, however, owing, perhaps, to the fact that the infected parent is taking mercury at the time, one or more of the children in the series escape. Sometimes the last-born is affected after a long interval of freedom, the strength of the mother failing from age, or from frequently repeated pregnancies, and the child suffering in consequence.

It is generally held also—but the evidence upon this point is much less satisfactory—that not only do the chances of escape increase, but that the disease itself becomes milder as the date of parental infection becomes more distant; and certainly it is not uncommon to find a long series of miscarriages, then a child born alive, but dying shortly after birth, and then several, one after the other, each apparently less affected than the one before. Against this, on the other hand, is the fact that syphilis, under whatever circumstances it occurs, is the same disease. It varies, beyond all doubt, immensely in different individuals, but there is no proof that such a thing as a mild inoculation or a stronger one is possible. If a child is infected through one of its parents, it may suffer from a

slight attack or from a severe one, but this does not depend upon the inoculation or the date of infection in the parents, but upon the child. Early miscarriages may very probably be accounted for by local affections of the uterus or placenta, the slighter severity in the later children by the improvement in the general health of the parents, and the occasional intensity in one of the last-born by the failing power of the mother, and the consequent feeble development and nutrition of the child.

The child may be affected either through the father or the mother or through both. It is generally believed that when the mother is diseased the child suffers more severely, and, no doubt, death of the fœtus before birth is commonly due to some affection of the uterus or placenta; but, except upon this point, there is no direct evidence one way or the other. The ordinary infection is through the father; the mother may show no sign of the disease, but, as was first pointed out by Colles, it is impossible to believe that she escapes. An infected child is almost certain to transmit the disease to a wet-nurse, never to its own mother.

If the father's attack is recent, the disease is communicated directly to the mother and the fœtus is exceedingly likely to die in utero from some local lesion. If the secondary stage (and with it the period of direct inoculability) is past, the ovum may, or may not, be rendered syphilitic by the spermatozoa. The only explanation of the fact that the mother is not infected by the child after birth, is that she has been already rendered syphilitic through the medium of the fœtus before birth. When this occurs, the mother does not suffer from secondary symptoms: the poison, beyond all doubt, is modified by the conditions under which it is acting (the length of the incubation period in the embryo is proof), and transmitted in this way does not appear to cause them; but tertiary lesions may follow later, for it is not uncommon to meet with them in women in whom the most careful inquiry fails to reveal any evidence of secondaries.

The child, there is no doubt, may become infected through the mother alone. If syphilis is acquired during the earlier part of pregnancy, the fœtus is affected and suffers from the ordinary effects of the congenital disease, just as if the virus had been communicated through the ovum or spermatozoa. In the later months there is a possibility that the child may escape.

### Congenital Syphilis.

The symptoms of congenital syphilis may make their appearance before birth or shortly after it, from three or four weeks to six months. In the former case the child is nearly always born dead. It is quite the exception to find any evidence of the disease upon a child born alive.

1. *Before Birth.*—It is probable that in a large proportion of the cases the death of the fœtus is due to disease of the uterus or placenta, the fœtus itself showing no definite sign. In a few, however, suppuration has been found in connection with the viscera; gummata are occasionally present, and certain changes which are admittedly syphilitic have been recorded in the bones.

2. *After Birth.*—As a rule, the child is born without the least evidence of any taint, healthy and well-nourished, and no sign of the disease makes its appearance for some weeks. Exceptionally, *Pemphigus* breaks out within a day or two and nearly always proves fatal.

A few weeks after birth the child begins to waste and grow pale. Its nose becomes stuffed up, so that it cannot take the breast for any length of time without letting go; a thin, watery discharge runs from it, the breathing becomes obstructed (whence the popular name, *snuffles*), and a *rash*, similar to that which occurs in the secondary stage of the acquired form, makes its appearance more or less all over the body. The favorite situations are the mucous membrane of the nose, mouth, and anus; the skin over the buttocks, owing to the generally moist and heated condition in which that part is kept; and the palms of the hands and the soles of the feet. On exposed surfaces it is for the most part

roseolous in character, not bright, but a dull, coppery red; where the epidermis is thicker it forms circular, scaly rings (miscalled psoriasis); between the nates and in other parts it assumes the form of condylomata, and in the mouth and at the anus it resembles, and is often associated with, thrush. At the angles of the mouth and nose it leaves deep fissures and cicatrices, and between the toes it forms rhagades; in other words, it exactly resembles the secondary eruption of the acquired form, modified by the peculiar condition of a baby's skin.

The peculiar color and polymorphic character of the eruption, the wasting and aged look on the countenance, the coincidence of snuffles, and the symmetrical character of the affection, render the diagnosis easy when all are present together. It is very difficult, however, in some cases. Wasting is sometimes absent, the child remaining bright and well-nourished throughout the attack. Coryza is often present without syphilis, and, owing to the small size of the nasal passage and the thickness of the mucous membrane, may lead to distinct snuffles, while eczema and impetigo are frequently symmetrical, and in some children are dull red instead of bright.

In severe cases the bones are affected as well. *Craniotabes*, wasting of the [illegible] parietal segments of the skull, so that in parts where the [illegible] bones are [illegible] the bone completely disappears, is probably more [illegible] than is known; but there are other affections which are definite. [illegible] swellings around the anterior fontanelle, one on each [illegible] and feel as if the substance of the fontanelle itself is marked [illegible]. Similar affections on the shafts of the [illegible] though they are more uncommon. *Infantile* [illegible] swelling forms around one or [illegible] and the child becomes entirely unable [illegible] is in a state of gelatiniform [illegible] and forms a soft, translucent [illegible] a sensation of yielding, and [illegible] Similar degeneration [illegible]

[illegible] most part, [illegible] At the same [illegible] never, in [illegible]

[illegible] there is a period of [illegible] of condylomata and [illegible] five or six years old, [illegible] rather, the [illegible] as an ear [illegible] of these it is [illegible] manifestations of any [illegible]

[illegible] and persis [illegible] *The* [illegible] in al [illegible] mucous mem [illegible] periosteum [illegible] *The* [illegible] scars [illegible] dead [illegible] especially [illegible] a most peculia [illegible] being straigh [illegible] the white of th [illegible] from above [illegible] which was firs

described by Hutchinson, is characteristic; it very rarely, if ever, occurs under any other circumstances, and it is caused by and is proportionate to the stomatitis of infancy. If this is severe at the time the dental papillæ are developing, they are so much reduced in size and so altered in shape that it is almost impossible to recognize them as teeth at all. Mercurial teeth, in which the enamel is defective transversely and marked by horizontal darkened grooves and pits, are totally different, but it is not uncommon to find the two associated. In exceptional cases, in which the stomatitis has been late or prolonged, a similar change is visible in the lateral ones as well; but it is only the median of the upper jaw that are definite and characteristic.

At puberty there is often a fresh outbreak, some of the lesions being distinctive, others resembling those of the tertiary period.

Of the former the most important are *interstitial keratitis* and *ostitis*. A symmetrical form *of deafness*, quite incurable, is also met with, but more rarely. The keratitis always attacks both eyes, although one is usually in advance of the other, lasts a variable number of months, and then clears up again, leaving, unless it has been very severe, little permanent defect. The ostitis is more intractable. It always attacks the shafts of the tibiæ, one or both, although it may appear in other bones as well. The shin grows out first and becomes tender; the leg seems to bow forward; then the whole shaft enlarges, and in a few months, or two or three years, the bone stands out, misshapen, massive, enormously thickened, and often increased in length. In the milder cases the exudation is diffuse and becomes organized; in the more severe ones gummata are present as well, especially on the periosteal surface, and cause superficial sequestræ, which separate with the most extreme slowness. Possibly this is due to the sclerosis, which may also account for the fact that iodide of potash is almost without influence; it relieves the pain for the moment and causes the gummata to diminish in size, but it does little or nothing more. In the worst of all the inflammation spreads to the ends of the bones, synovitis sets in, and at length, after lasting many years, with constant attacks of pain, the limb is reduced to a condition resembling an old, gnarled tree-trunk, covered all over with cicatrices. In the tibiæ this condition is very common and is absolutely distinctive; in other bones it is more rare, periosteal and myelitic gummata, resembling those of acquired syphilis, occurring instead. Very often the effect is rendered still more striking by the peculiar undeveloped condition of the skeleton. Congenital syphilis in this respect closely resembles rickets; not only do the bones of the extremities and face fail to grow, but they do not undergo the proportionate development of adult life; the type remains that of the child.

There is no lesion in acquired syphilis that is not also met with sometimes in the hereditary form. The skull may be almost destroyed by necrosis; iritis, choroiditis, and optic neuritis may occur; ulceration of the soft palate and perforation of the hard one, with necrosis of the septum and turbinate bones, are not infrequent, causing the most fearful ozæna. Gummata—visceral, subcutaneous, and muscular—are of common occurrence. Skin diseases, however, with the exception of a rapidly-spreading form of lupus, are rare, and the same may be said of degenerative lesions of the nervous system. I have met with ophthalmoplegia (complete) in a girl sixteen years of age, in whom the only evidence of disease, past or present, was the presence of a few cicatrices at the angles of the mouth; but probably many of the cases of epilepsy, idiocy, and other diseases of the nervous system are merely coincidences; at least, there is no direct evidence to connect them with the hereditary taint.

**Treatment.**—Excision. There is some evidence in favor of the view that early excision can prevent the further development of the disease; but it must be done within forty-eight hours, or three days at the utmost, and cases in which this is possible are altogether exceptional. By the time the chancre has developed it is certainly too late, and in this respect the analogy with such diseases as malignant pustule fails completely.

1. *General.*—The general principles of treatment are easily laid down. Mercury and the iodides of potash, soda, and ammonia are the only drugs that exert any direct influence upon the syphilitic virus and its effects; the details vary very widely. The first-named is chiefly in use in the earlier stages of the disease, although there are many cases in which its action is beneficial throughout; it seems to act as a specific, causing the primary induration to melt away much more rapidly than it otherwise would; delaying in a most remarkable manner the appearance of secondary symptoms; not unfrequently preventing them altogether, and rendering the whole course of the disease very much more mild; but it must be given with proper care. There is no doubt that, if used in an indiscriminate fashion, it is capable of producing the most ghastly results, necrosis of the bones of the face, for example; and also that certain people are peculiarly susceptible to its influence. Their number, however, is exceedingly small; if sufficient precautions are taken, they run practically no risk, and the danger is completely outbalanced by the extraordinary good it does to the majority.

How mercury should be given does not really seem of much importance so long as the method adopted agrees with the patient, brings him quickly under the influence of the drug, and is fairly convenient. It should be commenced at once, as soon as the diagnosis is made. It is true that sometimes of themselves secondary symptoms fail to develop after a hard chancre, but the prospect of this is too remote, and there is some evidence in favor of the view that, possibly because of the neglect of specific treatment in the earlier stages, cases of this kind not unfrequently suffer much more severely later. The administration should be continued, gradually but steadily increasing the amount, until the patient is definitely brought under the influence of the drug—until the teeth begin to feel too long, and it is painful to bite a crust; beyond this stage of incipient salivation it should never be carried. The treatment must be kept up with occasional intermissions until all the secondary symptoms, and especially the glandular enlargements, have disappeared. After that it may be dropped, although in most cases a short course, for a month or so, is advisable two or three times in the next two years.

Salivation, when it is rapidly induced, sometimes causes local lesions to disappear in a marvelous manner; but it has little or no influence upon the general disease; it compels the administration to be suspended at once, and there is some evidence to show that, even when it is not pushed, as it was in days gone by, it is exceedingly injurious, tubercular eruptions and rupia making their appearance afterward, during the period of forced inaction that must follow. The object at the present day is to begin very gradually, feeling the way, as it were, and to keep the patient under the influence of the drug for a considerable length of time, without ever pushing it so far that it must be left off. As soon as the point of incipient tenderness is reached the dose must be diminished and everything done to prevent the condition of the gums becoming worse. In this respect patients differ very greatly from each other. Independently of individual peculiarities, which sometimes are so strongly marked as almost to prevent the drug being taken at all, a great deal depends upon the condition of the teeth and the mode of life. If the teeth are decayed, or if there is a collection of tartar round them, tenderness begins much earlier, and the red line of incipient inflammation is distinct much sooner than when they are perfect; if, on the other hand, they have been lost from any cause, it is very difficult to affect the gums. Hutchinson has also pointed out that salivation is much more readily induced when a patient is confined to bed than when he is going about his every-day work, and that it is distinctly checked by the use of tonics. Abroad, where mercury is pushed to a much greater extent than is usual in England, especially for tertiary affections, strong astringent gargles are used to check the tendency.

The simplest and most convenient method is by the mouth in the *form of pills.* Hyd. c. cret. (gr. ij (.12 gramme) three times a day) hardly ever disagrees, especially if given with a grain of Dover's powder, and this may be continued for

many months without causing the least disturbance, gradually increasing the frequency of the dose (rather than the amount) if the patient does not resent it and the effect is not sufficiently rapid. Many patients are decidedly more comfortable and feel better while they are taking it, very probably from the action of the drug upon their liver. A grain, or a grain and a half (.06 or .09 gramme), of blue pill, with a small quantity of opium, may be used in the same way. Others prefer calomel, or the green iodide; but the latter is distinctly more inclined to caues purging.

*Inunction* is chiefly useful in those cases in which, in spite of the addition of opium, mercury persists in causing dyspepsia, loss of appetite, or diarrhœa. Otherwise it does not possess any real advantage; and, although they will put up with it abroad, when they devote themselves entirely to their own treatment, most patients object to it in England as intolerably dirty. Twenty to forty grains (2.40 to 4.80 grammes) of mercurial ointment are rubbed in, at first every other day, and then, if the effect is not sufficiently rapid, every day; the sides of the chest and abdomen, and the inner surfaces of the arms and thighs being the places usually selected, owing to the thinness of the skin and the absence of hair follicles. Flannel should be worn afterward, and the part should not be washed for twenty-four hours. Care should be taken to change the locality frequently, for fear of causing an eczematous eruption.

*Fumigation* with calomel may be tried with advantage where there is a copious skin eruption. The ordinary apparatus is a spirit lamp, with, over it, a metal saucer containing a small quantity of water; and in the middle of this a metal disc on which the calomel (twenty grains) (2.40 grammes) is placed. The patient is seated on a chair with a mackintosh, or, if this is not available, a blanket wrapped round him, reaching from the neck to the floor. When the lamp is lit, the water evaporates first, producing copious perspiration, and then, as soon as the disc becomes sufficiently heated, the calomel sublimes in the form of a fine vapor, and is deposited upon the skin while this is in a condition well prepared to receive it. If the throat is affected the patient may take the opportunity of inhaling some of the vapor. Afterward, as soon as the sublimation is complete, the patient should be wrapped up warmly and placed in bed without being wiped.

*Hypodermic injection* of bichloride of mercury (gr. $\frac{1}{3}$) (.02 gramme) into the substance of the muscles is used to a considerable extent upon the Continent, but has not found much favor in England, owing to the pain and risk of suppuration.

*Diet and Regimen.*—Whichever plan is adopted, it is absolutely essential that the patient should exercise the greatest care in his manner of living. Stimulants are better withheld altogether; old claret is the least objectionable. Everything that tends to disturb digestion must be avoided; rules for this, of course, vary with the individual. Clothing should be warm; exposure, especially at night, carefully guarded against, and a fair amount of time allowed for sleep. Warm baths should be taken twice a week at night; but if the patient is accustomed to it, there is no objection to the cold bath in the morning, always provided the reaction is good. When the skin eruption is of an obstinate character, vapor baths, or small doses of pilocarpine, sometimes effect a rapid improvement. Smoking is strictly prohibited; it is almost impossible to cure a tongue or a throat that is constantly being irritated with hot tobacco-smoke. Exercise in the open air is very essential; and where the patient's circumstances admit of it, residence at the seaside, or, better still, a sea voyage, is of very great benefit. Rupia, in particular, frequently resists everything until the patient goes to the sea. It cannot be too strongly impressed upon those suffering from syphilis that the only prospect of cure is early and thorough treatment, and that proper attention to their general condition is quite as important as the administration of mercury.

The iodides are of little use at the commencement of the disease. It has never been proved that they exert any special influence upon the primary induration or the secondary eruptions. On the other hand, when the bones are involved,

and in the later stages, when there is a cellular exudation of a chronic character, rather than acute hyperæmia, they give relief almost at once. It is not claimed for them, as it sometimes is for mercury, that the yare able to cure syphilis; their influence is rather upon the manifestations of the disease than the disease itself; but in their proper place they are scarcely less valuable, and, when mercury cannot be taken, are practically the only drugs to rely upon. Iodide of potash is the one usually selected, but the corresponding salts of sodium and ammonia are equally powerful and possess the advantage of not being so depressing in their action.

The dose varies from a grain to a drachm (.06 to 3.60 grammes) or more three times a day. Small ones should always be used at the beginning; if they do not succeed the amount may be increased step by step, and it is not uncommon for a distinct improvement to follow each addition, but the dose that is reached in this way is often enormous. A large one at first might be unnecessary and very possibly harmful. Many patients are peculiarly affected by it. It nearly always brings on a profuse watery coryza with irritation of the conjunctiva, but usually this subsides in the course of a few days, even if the drug is continued. Exceptionally it is severe, not abating in the least, and is associated with such intense depression that patients absolutely refuse to take any iodine at all. This occurs especially with the potash salt, and, although it may be to some extent obviated by the addition of carbonate of ammonia, it is better in such cases always to prescribe the soda and ammonia ones instead.

Cutaneous eruptions are frequently caused by the iodides, the three in this respect being apparently equal. Acne is the most common, occurring upon the usual situations, the face and shoulders; but much more severe vesicular and bullous eruptions are sometimes met with, and purpuric spots occasionally make their appearances upon the lower extremities. Wasting and diminished sexual power are not uncommon during the administration, but the effect is not a lasting one, and cases in which atrophy of the testes or the breasts is stated to have followed are for the most part open to suspicion.

The bichloride of mercury and iodide of potash are frequently given together (forming a biniodide soluble in excess of the potash salt), especially in the later stages of the disease, when it is wished to continue the use of the drug for a considerable length of time without risk of salivation.

Other drugs are of use in individual cases. Iron is the most general. By itself it has little or no effect upon the anæmia, but with mercury it very soon brings about a complete change. Arsenic is sometimes useful, but there is no proof that quinine or sarsaparilla has any influence upon the disease. Cod-liver oil, quinine, and other tonics are frequently required in the later stages, but according to Hutchinson, they rather delay the action of mercury at the commencement.

2. *Local and Special Treatment.*—This is equally important; it often happens that an eruption or a sore which resists everything internally yields at once to local applications.

Lotio nigra, or a very weak mercurial ointment, is the best application for a hard *chancre*. The ordinary mild forms of secondary eruption disappear rapidly as soon as the effect of the mercury begins to make itself felt; but the more severe ones, particularly in the later stages, when there are local causes at work, require something further.

*Sore throat*, ulcers in the tonsils, and roseolous spots on the mucous membrane of the mouth, may be treated with a gargle of equal parts of chlorate of potash and lotio nigra; or of bichloride of mercury (gr. ¼ ad ℥j) (.015 to 32 grammes) and bark. Calomel fumigation is useful where there is obstinate ulceration in a specially inaccessible part. The drug is placed in a glass tube drawn out to a fine point at one end, and at the other connected with an ordinary ball syringe. The calomel is vaporized by means of a spirit lamp, and a gentle current of air sent through the tube, so that a fine film is deposited in any spot that requires it.

*Condylomata* and mucous patches must be kept dry. Equal parts of calomel

and oxide of zinc may be dusted over cutaneous ones. When they occur upon the tongue they can be painted over with a solution of bichloride (gr. ij ad ℥j) (.12 to 32 grammes), or of bicyanide of mercury (gr. v ad ℥j) (.30 to 32 grammes). Cracks and painful fissures at the angles of the nose and lips may be cured, as a rule, by a single application of nitrate of silver (solid); but they tend obstinately to return.

*Phagedæna* and the spreading form of syphilitic lupus require iodoform and continuous warm baths; or, if they occur upon the face, the acid nitrate of mercury freely applied. The pain is relieved to some extent by cocaine. Sometimes the chronic persistent variety requires scraping.

*Rupia* is the most difficult of all the early syphilitic manifestations. It is most common in the intemperate and those who have been salivated; but sometimes it breaks out without apparent reason. Very small doses of mercury seem to agree with it best, sometimes in conjunction with iodide; but whenever it is possible the patient should be sent to the sea, and made to lead a perfectly healthy and temperate life. Iodoform is the best local application to the ulcers as soon as the scab can be detached.

Palmar and plantar *psoriasis* may be treated either with an ointment of the ammonio-chloride of mercury (gr. xv ad ℥j) (.90 to 32 grammes) or with the ordinary blue ointment, a piece of rubber or other impervious plaster being fixed over the whole dressing, so as to ensure the softening of the epidermis and the absorption of the drug.

Early secondary *periostitis* disappears in a day under the influence of the iodide. The later affections of bone do not get well so readily, but the pain can usually be relieved at once. Sclerosing ostitis and hyperostosis in hereditary syphilis are exceptions; iodide seems scarcely to have any effect upon them. If there is a gumma on the bone the exudation is absorbed, but the inflammation seems to progress unchecked beneath. Subcutaneous division of the periosteum and linear osteotomy are occasionally resorted to when the pain is severe, but the benefit is rarely more than temporary. Mercury is equally powerless, and local applications, with the possible exception of the actual cautery, answer no better. Fortunately the pain seems gradually to wear itself out after a time; in all probability the tension and compression of the nerve filaments at length cause atrophy; but it may be years before this happens.

*Gummata* and serpiginous ulcerations in the tertiary period require iodide freely. Small quantities of mercury are exceedingly beneficial at the same time, either applied locally in the form of black wash, or given as the biniodide, internally. This is particularly useful where it is desired to keep up the administration for any length of time.

In chronic affections of the *nervous system* it answers best to begin with small doses of mercury, and gradually to push it until a distinct effect is produced upon the gums. If this cannot be borne, iodide must be given; but alone it rarely succeeds so well. After a certain time the biniodide may be tried and kept up for a year or more. Relapses are very common.

Iritis and neuro-retinitis require the administration of mercury to be pushed vigorously. In cases such as these it is necessary to check the exudation as soon as possible.

In the inherited form either small doses of hyd. c. cret. may be given night and morning, or inunction may be tried, a small quantity of mercurial ointment being placed inside a flannel binder sewn around the body. Iron is usually very beneficial at the same time. The later affections that appear at puberty must be treated as the tertiary ones of the acquired form; but they are seldom so tractable, and usually require mercury in addition to the iodide.

If the attack is recent, or if there have been recent miscarriages, small doses of mercury should be taken during the whole course of pregnancy. If the father is infected precautions of a similar character should be adopted. Marriage should on no account be sanctioned until at least two years have elapsed from the original attack and six months from the disappearance of the last symptom.

## LEPROSY.

Leprosy is a contagious disease, very chronic in its course, in many respects analogous to syphilis, and caused by a specific bacillus, which resembles that of tubercle in its behavior to staining reagents, though its size is smaller.

The disease is very widely spread. Formerly it was common in England and Scotland; at the present day it is only met with when imported. In Norway, Iceland, the East and West Indies, Palestine, and other countries, it is of frequent occurrence. It is not connected with diet, climate, syphilis, malaria, or other diseases, except in so far as they lower the vitality of the tissues and weaken their power of resistance. Heredity is doubtful; but there is no question as to its being contagious, although probably individual predisposition varies very considerably.

**Pathology.**—The essential feature in all the lesions, no matter how much they differ in appearance, is the production of masses of granulation-tissue, similar to that formed in tubercle and syphilis, with giant-cells, round-cells, and all the intermediate varieties that occur as a result of chronic irritation. The so-called lepra-cells are merely leucocytes, connective-tissue corpuscles, or epithelioid cells from the interior of the lymphatics or capillaries, transformed by the action of the bacillus; every grade can be found between the leucocyte with the single germ and the lepra-cell with myriads. The subsequent development depends partly upon the stage of the disease, partly upon the condition of the patient, and the presence or not of other organisms, especially those that cause suppuration. The newly-formed granulation-tissue is never very well supplied with vessels; even at the commencement of the disease it wastes away, undergoing caseation and absorption, or developing into dense fibroid tissue; later it breaks down, suppuration sets in, and not unfrequently phagedænic ulceration with immense destruction follows. The changes are the same whether it occurs upon the skin, in internal organs, or on mucous surfaces, the internal complications to which it gives rise not uncommonly proving the immediate cause of death.

**Symptoms.**—Leprosy exists in two forms, the tubercular and the anæsthetic; the former is the more common in temperate climates, the latter in the tropics, but there is no essential difference between them, and they may occur in the same patient as a mixed form. The bacillus has only been proved to exist in the tuberculated variety.

Certain vague prodromata, which may last months or even years, are present in both. Chills with occasional attacks of fever, but very rarely anything like a genuine rigor, weakness, drowsiness, and vertigo are the most common, varying from time to time, and indicating little more than a general failure of health. The local symptoms are characteristic.

1. *The tuberculated variety.*—The skin and subcutaneous tissue usually suffer first, especially on the face: then the mucous membrane of the mouth, tongue, and larynx; finally it becomes general.

Erythematous patches, little nodules, tubercles, and finally giant masses, the size of an egg and even larger, make their appearance in successive crops, gradually getting worse and worse, and each outbreak attended with a feverish attack. At first the skin only is involved; dusky, red, slightly raised patches of various size, associated with hyperæsthesia, form upon the face, forehead, arms (especially the extensor surface), and legs. They are fairly well defined at the margin, and after lasting some little time disappear, leaving the skin where they were pale, pigmented, and atrophied. The hyperæsthesia disappears with the exudation, and is succeeded by distinct impairment, but there is no general anæsthesia, as in the other form.

Then, as the disease advances, these are succeeded by crops of dusky red or brown nodules and tubercles, scaly upon the surface, and involving the deeper tissues as well as the skin. The smaller and earlier ones disappear as before; the larger ones, although they too may become absorbed, not unfrequently break down

and suppurate, forming deep, red, and glazed ulcers, which heal very slowly. By degrees, as the tubercles become more frequent and larger and the surrounding inflammation more severe, the aspect of the face is completely changed. The eyelids, nose, lips, and ears are enormously increased in size, and distorted by great bosses and masses of œdematous tissue interspersed with scars. The forehead is covered with folds of thickened hypertrophied skin; the hands and arms and the trunk are more or less deformed in the same way. The general health fails; strength and energy are lost; sexual power disappears, and a condition of complete prostration follows.

Other symptoms are caused by similar eruptions upon the mucous membranes. The voice becomes altered; ozæna sets in from ulceration of the nose; diarrhœa is not uncommon; pulmonary complaints follow from the inhalation of foul and putrid discharges; and the immediate end is not unfrequently caused by some low type of inflammation consequent upon phagedænic ulceration of the mouth and fauces.

2. *The anæsthetic variety* is attended by similar prodromata. The local symptoms, however, are traceable almost entirely to disease of the nerves.

Patches of hyperæsthesia, with shooting pains and eruptions of small bullæ upon the hands, forearms, and legs, are the earliest sign. The skin of the fingers becomes glossy and red, and the muscles waste, corresponding to the distribution of one of the nerves, especially the ulnar or median, which can often be felt enlarged. Then dry, yellowish-white, scurfy spots appear upon the back and shoulders and over the knees and elbow. In the centre of each sensation is lost; round the margin, which is often raised and even vesicular, there is for the time some degree of hyperæsthesia. These keep increasing in size and number; the area of anæsthesia slowly spreads, muscular wasting becomes more rapid; the joints become stiff and contracted; and finally, after many years' duration, the skin over the whole body may be atrophied, dry, and white or yellow, according to the depth of complexion.

Bullæ are not uncommon here and there upon the exposed parts; perforating ulcer may occur upon the foot; severe injuries are often sustained owing to the total absence of sensation, and dry or moist gangrene occasionally sets in and follows its usual course, according to the presence of septic decomposition or not.

In addition, the most extraordinary deformities are caused by absorption and wasting. The phalanges of the fingers may disappear until the nails rest upon the ends of the metacarpal bones; the hands may assume a peculiar claw-like form from atrophy of the interossei; drop-wrist may occur; the toes may disappear; and what with gangrene, wasting, interstitial absorption, and ulceration (which, however, is rarely so severe as in the tuberculated form) the most extreme degree of mutilation may be produced.

The immediate cause is the infiltration of the growth into the substance of the nerves, giving rise at first to irritation and hyperæsthesia, later to wasting with anæsthesia and degenerative changes, the exact locality of the symptoms depending in each case upon the fibres involved.

**Treatment.**—A certain amount of improvement is stated to have followed the administration of Gurjun oil (in lime water, 3 grs.) (.18 gramme) twice a day and Chaulmoogra oil (in perles, each containing three minims), gradually increasing the dose until the patient's limit of endurance was reached; and this may be combined with their external application. For the rest, all that can be done is to treat symptoms as they arise, paying special attention to hygienic measures and trying to check ulceration as far as possible. In the anæsthetic variety temporary improvement has been obtained by nerve-stretching and nerve-splitting, the operation probably acting by releasing the fibres from constriction or pressure.

## TETANUS.

Tetanus is a disease characterized by tonic contraction of voluntary muscles, either those belonging to a single group of actions or those of the whole body. It usually follows a wound, but as this may be of the most trivial description—a mere pin-prick, for instance—or be wanting altogether, it cannot be regarded as essential; and it may be acute, proving fatal within a few hours; or chronic, lasting for days or weeks.

Various terms are applied to it, according to the muscles involved. It is known as *trismus* when those connected with mastication are rigid (whence the popular name, locked jaw"), and *trismus nascentium* or *neonatorum* when it occurs shortly after birth. If it follows an injury to the head it is sometimes described as *tetanus hydrophobicus*, owing to the spasmodic contraction of the muscles of deglutition which is occasionally present; and as *opisthotonos* when the head is thrown back; *emprosthotonos*, when the body is curved forward; and *pleurosthotonos*, when it is thrown to one side. These terms, however, are merely descriptive, and the two last conditions are exceedingly rare.

**Etiology.**—Tetanus is especially common in certain races, and in certain climates, but it may attack any one. Lacerated wounds, those in which there is a foreign body embedded, and gunshot injuries of the lower extremities, are said to be more often followed by it than others, and decomposition appears to be favorable to it; but it may occur without an open wound (as in simple fractures) and even without an injury of any kind. Exposure to cold and wet or to great changes of temperature is usually stated to be a cause, but it may be merely a predisposing one. No doubt cases frequently occur together, and at times well-marked epidemics of tetanus have been recorded; but whether this is due to contagion or to the fact that the patients were simultaneously exposed to the influence of the same agencies, is not clear. It is a very common disease in horses and cattle generally, but dogs seem especially exempt.

There are two views with regard to its pathology: the one, that it is due to an abnormal condition of a peripheral nerve, which either extends directly to the spinal cord or causes general reflex spasm; the other, that it is the product of some poison excreted by a living organism. Neither can be considered proved, and not improbably there is an element of truth in both.

(A) The former rests chiefly on clinical evidence. There is a certain small but undoubted number of cases in which a distinct nerve lesion has been found (a foreign body, for example, pressing on a nerve or embedded in it) and in which the symptoms have subsided after its removal. It has been known to occur even in simple fractures from the pressure of a displaced fragment.

Further, distinct improvement occasionally follows nerve section, although, unhappily, the number of acute cases in which this has taken place is very small. The success that sometimes attends excision of the wound or amputation does not point to anything, for it may be explained by the fact that the poison is to some extent a local production, as in malignant pustule.

Sometimes in man, and to a much greater extent in animals, the tetanic symptoms, instead of beginning as trismus, show themselves first in the injured limb, and even in the muscles that correspond with the distribution of the injured nerves—in the biceps, for example, when the musculo-cutaneous nerve is involved. This, however, is capable of being explained on either theory.

The same may be said of the fact that occasionally in tetanus, spasmodic attacks may be excited by pressing upon the trunk of the nerve that is believed to be affected; upon the ulnar nerve at the elbow, for example, when the injury affects the little finger. This merely shows that when the nervous system is in the peculiarly excitable condition produced by this disease, the slightest stimulus can call forth an entirely disproportionate result.

Nor is it of much importance that in a few exceptional cases evidence of nerve irritation (swelling, hyperæmia, cellular infiltration, etc.) has been found

in the region of the wound. If tetanus can be caused by mechanical irritation of a peripheral nerve, it should be much more common than it is; it should follow neuritis and operations upon nerves; and sutures and ligatures, which must often involve nerve filaments, should constantly give rise to it, for the smallest wound is enough. Moreover, the actual number of cases in which any evidence of this kind has been found is exceedingly small; in the great majority the condition of the nerves round the seat of injury presents nothing abnormal; and in a certain proportion there is no injury at all. In short, it must be admitted that, although it is at present impossible to explain some cases, the theory that tetanus can be caused by mechanical irritation only is not proved.

(B) There is more evidence in favor of the other view. The fact that the disease is distinctly endemic as well as epidemic, that it occurs again and again in certain hospitals and in certain wards, until suddenly there is some alteration—some improvement in the ventilation, perhaps—is most suggestive. Of children born in the Rotunda at Dublin, at one time no less than seventeen per cent. used to die from it; and epidemics on a smaller scale have been recorded in connection with many other institutions.

The existence of an incubation period again deserves consideration. It is true it is most irregular; the disease may break out within a few hours after an injury, or not occur for weeks; but when the conditions are the same—in new-born children, for example—there is such uniformity that in some parts of the country the disease is known as "nine-day spasms." Moreover, it is not a little singular that, as a rule, the attack is milder, the course more chronic, and the prognosis better, in proportion to the length of time that has elapsed since the receipt of the injury. Acute cases rarely survive; chronic ones and those that are not due to a wound not uncommonly. It would almost seem as if the shortness of the incubation period and the virulence of the poison were in some way connected with the tissue-changes that occur soon after the infliction of a wound.

The results of experiment are more definite. Although there is a certain amount of discrepancy, the balance of evidence is distinctly in favor of its being due to a form of bacillus, living in moist earth, widely distributed, and closely associated with the bacillus of putrefaction, so that it is exceedingly difficult to obtain a pure cultivation. It is found chiefly in the immediate region of the wound (a fact which may be of some significance in connection with treatment); the blood is rarely infective, so far, at least, as animals are concerned (in men this is not so certain, especially when the disease is acute); evidence of its existence has been found in the spinal cord and medulla oblongata; and it can be cultivated in proper media, although with some difficulty.

The disease has been produced in other ways: by the hypodermic introduction of earth; by using in the same way fragments of tissues and washings of wounds from patients who have died from the disease; by inoculations with dust (it is recorded that out of seventy people injured in a church during an earthquake at Bajardo, no less than seven were attacked by tetanus, and that animals inoculated with dust from the same place suffered in the same way); by a culture obtained from a splinter of wood that had already caused an attack of tetanus; and by using some of the dried discharge from a pair of forceps that had been employed in castrating horses.

It is true that there is some discrepancy about the form of the bacillus; some observers have been unable to find it at all; some have succeeded with blood, others not; some have found it necessary to make use of subdural injections, while with others hypodermic ones have answered better; and emulsions of the spinal cord are according to some innocuous, according to others certainly fatal. For all that, the broad facts must be admitted, that the disease (or one so strikingly like it that it cannot be told from it) can be caused almost at will by the injection of certain substances which usually contain the same form of organisms. In all probability it is really due to certain albumoses which have been extracted from

cultivations, and which have been shown to be capable of causing tetanic convulsions. That the disease in animals usually begins in or near the seat of inoculation is not really very much to the point, for such cases, though they may be rare, are certainly met with in man. [Kitasato obtained, by an ingenious process, a pure culture of the tetanus bacillus of Nicolaier, and by inoculation of animals reproduced the disease. Verneuil is of opinion that contact with horses is a necessary factor in the causation of tetanus. Larrey long ago cited instances where the use of soiled straw taken from a stable and used by wounded soldiers as bedding was followed by tetanus. The tetanus bacillus is, however, one of the most widely distributed in nature. Brieger has also found from pure cultures of the tetanus bacillus certain toxalbumins—tetanin, tetanotoxin, spasmotoxine, and spasmodine—and with these poisons he produced tetanus. It therefore now seems probable that the products of the tetanus bacilli are the immediate cause of the disease.]

The post-mortem appearances in tetanus are not distinctive in any way. [Inoculations made from cadavers dead from tetanus have reproduced the disease.] Occasionally evidence of neuritis is found, but it is decidedly rare; rupture of muscles and engorgement from asphyxia might be expected. In one or two instances curious rounded points visible to the naked eye have been found in the spinal cord and medulla oblongata; they stained readily with carmine and logwood, were apparently homogeneous, and pushed aside the nerve fibres round them; but it is not known what significance is to be attached to them. Dilatation of the perivascular lymphatics in the brain has also been described.

**Symptoms.**—Premonitory symptoms are rare. The first definite sign is usually pain and stiffness about the muscles of the jaw and neck; the patient complains of sore throat or stiff neck, and imagines he has caught cold. Then it is noticed that the mouth cannot be opened to its full extent, though it can still be closed, and that mastication and deglutition are difficult. Every attempt brings on painful spasms, and seems to make the contraction worse. By degrees, sometimes rapid, sometimes slow, the painful contraction and the rigidity extend to other muscles near. The orbicularis oris may be contracted; more frequently the lips are drawn apart (risus sardonicus), the neck is drawn back so that the head bores its way into the pillow, the thorax becomes rigid and the abdomen hard and board-like; often there is a fearful pain extending from the ensiform cartilage backward; respiration becomes shallow and rapid; the forehead is bathed with sweat; the pulse small and feeble; and the whole face expressive of the most intense anxiety and suffering.

Gradually, as the disease advances, all the muscles of the trunk become hard and rigid; the thighs and legs are extended or drawn apart, and the shoulders and arms thrown out. The fingers and wrists usually escape. Meanwhile the convulsions become more and more severe, and the interval shorter. Paroxysmal attacks with the most violent contractions come on every few minutes, and with every sound or breath of air; the face is distorted; the body wrenched and twisted with the utmost violence into inconceivable positions; the limbs jerked wildly about, until at length the muscles themselves give way or are ruptured.

Consciousness is retained to the last. The pain in the acute forms is agonizing. Sleep is impossible, except in short snatches from sheer exhaustion; it is said that then there is slight relaxation. The bowels are confined, the urine scanty, and toward the end the temperature often begins to rise, and it may continue after death until it reaches 112° F., or even more. Sometimes, just at the end, there is a brief lull in the severity of the symptoms, but no hope is to be derived from that. Death is generally due to asphyxia or heart-failure. If this does not happen, the exhaustion may be so extreme as to prove fatal of itself. In chronic cases the convulsions diminish in intensity until only a certain degree of tonic contraction is left; a relapse is always possible so long as the slightest trace persists.

**Prognosis.**—Acute tetanus is nearly always fatal; death may occur in four

or five hours. After the fourth day the chances of recovery increase. Idiopathic tetanus and that which occurs late after the infliction of a wound are very much more hopeful.

There is rarely any difficulty in the diagnosis, although it must be borne in mind that a very severe form of trismus if not uncommon when the wisdom-teeth are coming through. In any case of doubt the interior of the mouth should be thoroughly examined under an anæsthetic. Hysteria, cerebro-spinal meningitis, attended with opisthotonos, and hydrophobia occasionally cause a little hesitation. The last mentioned is sometimes simulated very closely when tetanus complicates injuries of the head. Strychnia-poisoning reaches its maximum in the first hour, and then either proves fatal or gradually subsides.

**Treatment.**—The wound should be thoroughly explored, and if the injury is a recent one and the attack acute, excised. It may do no good, but there is some little evidence to show that the poison (like that of malignant pustule) is a local one, in a measure at least; and it certainly can do no harm. Nerve-section and nerve-stretching fail in acute cases, where their help is wanted.

The bowels should be opened thoroughly, once for all; the patient placed in a darkened room and kept absolutely quiet. If he can swallow, beef-tea, eggs, brandy, and wine may be given freely. If not, nutrient enemata must be tried. According to Sir Thomas Watson, wine in large doses, and nourishing diet, are more likely to succeed than any drug.

Chloral and bromide of potash have undoubtedly some influence upon the severity of the spasms. Chloroform inhalation has been tried and kept up for hours, but with only a temporary benefit, if any. Curare has failed completely; opium is of very little use; Calabar-bean raised a certain amount of hope for a time; but no drug has the least effect upon the disease, though one or two may alleviate the most painful of the symptoms.

## RABIES.

Rabies (or hydrophobia, as it is called in man, from one of its prominent symptoms) is a specific disease resulting from the inoculation of the virus from a rabid animal. There is no proof that it ever originates *de novo;* it is always communicated, chiefly from dogs, cats, and wolves, although exceptional instances of it having been transmitted from herbivora are on record; and human saliva and human tissues have proved infective in the case of animals. Although the poison has not yet been isolated, there can be no doubt that it is the product of a living organism; it is contained in the saliva and in the blood, but its most certain habitat is the central nervous system; inoculation with the two former fail not unfrequently; with the latter, very seldom; and it is capable of indefinite multiplication within the body. Certain people and certain dogs seem naturally to possess immunity, but probably this is not so common as at first sight it appears to be, many of the cases being really due to ineffective inoculation.

The only morbid changes that are found with any constancy are in the lower part of the medulla oblongata, round the respiratory and deglutition centres, and sometimes in the gray substance of the cord. They consist chiefly in perivascular infiltration, with glandular degeneration of the cells themselves. Congestion of the brain is sometimes present, and the pharynx, fauces, and salivary glands are in many instances deeply injected and stained with blood.

**Symptoms.**—The symptoms of rabies in dogs differ in many respects from those of hydrophobia in man, but there is no doubt as to the identity of the two diseases.

In the former the incubation period is rarely under a fortnight, very rarely over three months. At first there is merely an alteration in general behavior; the animal is agitated and restless; it may still be obedient, but it is very irritable toward strangers; there is a constant tendency to gnaw everything and to swallow

all sorts of substances; in some cases the wound appears to annoy it; and the bark is peculiar and characteristic, ending in a long-drawn howl. This, in two or three days, is followed by the second or furious stage, in which the animal, although it appears to wish to avoid injuring those it knows, seems compelled to bite at everything and every one round. There is no fear of water; a dog will often plunge his head in and drink freely; but there are certainly hallucinations, coming on at intervals, although the animal is conscious and has not lost all control over itself. The final stage of paralysis soon follows, the strength rapidly failing, often in the hind legs first, and complete prostration setting in. In other animals the symptoms are very much the same, varying, of course, with the habits and general mode of life. In rabbits, for example, the first two stages are not present, and the disease begins with paralysis. Sometimes the same thing occurs in dogs, the so-called dumb-madness, and even in man.

In man the incubation period is more variable. Without subscribing to cases in which it is said to have lasted ten years and more, there can be no doubt as to its having been as long as fifteen months. On the other hand, it may be only a fortnight, especially when the bite is on the face and the animal was a wolf, or, what is probably nearly as bad, a cat. As might have been expected, the shortest period is often associated with severe and extensive injuries. [In two cases under the personal observation of Professor Senn the stage of incubation lasted forty-two days.] The wound may suppurate and appear unhealthy, but this is not due to the rabic virus; inoculation wounds performed with due precautions never give rise to inflammation.

The stages are the same as in the dog. A certain degree of uneasiness is often noticed about the scar; it may be red and irritable, and tingling sensations are not unfrequently complained of. This may last for two or three days before the depression begins, or it may be absent altogether. The patient becomes restless and uneasy, without being able to assign a cause; there is the most extreme depression; insomnia is of frequent occurrence; there is complete loss of energy, and in many cases irritability and general *malaise*. The second stage usually sets in suddenly, with a feeling of fullness and constriction about the throat. There is no tonic contraction as in tetanus, but successive convulsive spasms, of the most violent character, involving particularly the muscles of deglutition and respiration, and excited by the least breath of air or the slightest sound. Sometimes they are so severe as to threaten death from suffocation; often there is marked opisthotonos, but in the intervals there is usually complete relaxation. General hyperæsthesia is the rule; frequently there is great excitement of the sexual organs; hallucinations are of common occurrence, and the patient may be exceedingly violent, but there is rarely anything like mania, and intervals of self-control are nearly always present from time to time. The pulse is small and frequent; the secretion of saliva is profuse but viscid; the tone of the voice is altered; the urine is scanty, often containing albumin, and there is, as a rule, intense thirst, every attempt to alleviate it, or even the idea of drinking, bringing on violent convulsions. Gradually, after lasting perhaps forty-eight hours, the attacks diminish in severity; if life is sufficiently prolonged, a condition of rapidly-ascending paralysis sets in (probably, as pointed out by Horsley, the ascending paralysis of Landry was really hydrophobia), and the patient sinks, retaining consciousness more or less to the end. Death may occur during the second stage, from asphyxia or from heart failure; it rarely happens that the case lasts more than four days from the first commencement of the actual symptoms, although in a few instances the patient has lingered for a week.

Although some of the symptoms, even the hydrophobia, are occasionally wanting, there is rarely any difficulty in the diagnosis. Tetanus, especially that form of it which sometimes follows wound of the head, resembles it more closely than anything else, but trismus is absent in rabies, and there are always periods of remission. Hysteria, hystero-epilepsy, and even mania have been mistaken

for it, and there is a certain number of cases on record in which all the symptoms have been present, and in which death has followed, without its being possible to find any evidence or any history of inoculation.

**Prognosis.**—The disease, if left to itself, is absolutely fatal. No authenticated case of recovery after the first symptoms have appeared is known, at least in human beings; in one of Pasteur's experiments a dog recovered, and subsequently showed complete immunity.

What proportion of those who are bitten by infected animals suffer from the disease is very difficult to estimate. In the case of dog-bites it seems to be, at the lowest estimate, fifteen per cent.; cat-bites are worse; and wolf-bites, especially on the face, far worse still—no less than eighty per cent. of these are said to prove fatal. The length of the period of incubation varies in the same manner, but possibly this may be accounted for by the greater severity of the injury. Bites on exposed parts are more serious than when the teeth have to pass through several layers of clothes first.

**Treatment.**—A tight ligature should be placed at once above the wound, and bleeding encouraged as much as possible. It is not safe for any one else to suck the wound, as the least abrasion of the mucous membrane is sufficient. The sooner the whole injured surface is excised or thoroughly cauterized the better.

No drug has the least influence upon the progress of the disease, although chloral and morphia may relieve the pain and diminish the severity of the spasms. The patient must be kept perfectly quiet, in the dark; thirst must be relieved as far as possible by rectal injections—if, that is to say, there is the ordinary difficulty in swallowing—and any food that can be taken must be given. Tracheotomy is very rarely required, and such remedies as hot or vapor baths only serve to accelerate the end.

The only treatment of any service at all is the inoculation plan, discovered and perfected by Pasteur, and by which he has succeeded in reducing the mortality to 1.47 per cent. on the whole number (2164); and to a very much lower figure still, if only the later cases, and those which applied for treatment soon after the injury, are reckoned.

The most recent and complete account of Pasteur's method is that given by Dr. Ruffer at the Leeds meeting of the British Medical Association. The virus is invariably present in the cerebro-spinal nerve-centres. If the rabbit is inoculated under the dura mater with an emulsion made from the medulla of a rabid dog, the first symptoms appear within fifteen days, never earlier than nine. If the medulla of this rabbit is used to infect a second, the period of incubation is shortened; and if this system is repeated eighty times, at length what Pasteur terms "fixed virus" is reached, a poison, that is to say, which has a period of incubation of from six to seven days, and always proves fatal on the tenth.

The duration of life of the rabic organism is very limited. If the spinal cord of a rabbit that has died of hydrophobia is preserved in a sterilized bottle, the air of which is kept dry by means of caustic potash, the organisms gradually die off, until after ten or eleven days no more are left alive; only the chemical products of their action are still there. An emulsion made from a cord in this condition is used to begin the treatment.

It has been proved that some pathogenic organisms, when growing in suitable media, produce chemical substances which, when injected into an animal, enable that animal to resist the action of the specific organism itself. The object that Pasteur had in view was, by treating the patient during the period of incubation, to render him insusceptible to the disease.

At first an attempt was made to effect this by injecting an emulsion of fresh spinal cord; this would contain living organisms, and their chemical products too; the latter would act at once, and confer immunity before the former had passed the incubation stage, but success was not certain.

By using a spinal cord that has been kept until all the organisms have died

out, only the protecting substance is injected, although probably the quantit small, and, by repeated injections, each time making use of a cord that is one less old than the one before (and therefore contains more both of the protect substances and of the germs), at length a condition of complete insusceptibilit reached before the incubation period of the original infection is exhaust Thus, on the first day of treatment an emulsion from a spinal cord dried for fo teen days, and another dried for thirteen, is injected; on the second day emulsion from one dried for twelve days, and another from one dried for elev on the third, two more, one ten days old and one nine; until, on the fifth da cord dried for six days only is used. The treatment is continued for sixteen da each injection consisting of about half a cubic centimetre of spinal cord crus in two cubic centimetres of sterilized beef-tea.

For most cases Pasteur found this course sufficiently rapid in its action, not for wolf-bites, or bites upon the face. For these, what is known as intensive method is employed, the same in principle but more rapidly carried o four injections being made on the first day, four on the second, and two on third, so that on the fourth day a cord is used which has only been kept five da Of fifty patients treated in this way not one died.

Dr. Ruffer states, in the most positive manner, that no case is on record which death has been produced by Pasteur's treatment.

# CHAPTER V.

## *TUMORS.*

By Frederick S. Eve, F.R.C.S.

[Tumors may be divided into two general classes, *neoplasms* and cysts, but many pathologists only admit the neoplasms.]

*Cysts or Cystomata.*—A cyst may be broadly defined as a cavity with well-defined walls and fluid contents. The walls are composed of connective tissue and are usually lined with epi- or endo-thelium.

A cyst may be single or *simple.* Many cysts may be grouped together to form a *conglomerate* cystic tumor, or a cystic tumor may be *multi-locular.* The latter term is applied when the mass is broken up into numerous cavities or loculi by partitions, and this condition is produced either by fusion of adjoining cysts or by the growth of secondary cysts within the walls of the primary cavities, as in ovarian tumors. The secondary cysts either project externally (exogenous cysts) or internally (endogenous). A cyst is said to be *proliferous* when a growth or vegetation springs from its walls into its cavity.

Cysts have commonly been classified according to the nature of their contents, as: sebaccous, mucous, serous, mucoid, and colloid.

A primary classification, according to their source, seems preferable, as follows:—

I. Cysts arising in normal structures.

II. Cysts arising in persistent fœtal rudiments and misplaced fœtal structures (congenital cysts).

III. Cysts formed within or of the nature of tumor formations.

### I. CYSTS ARISING IN NORMAL STRUCTURES.

The first class, which comprises the larger number, may be further subdivided, on an anatomical basis, thus:—

(*a*) Cysts formed by distention of serous sacs and synovial membranes, or of diverticula from the same; and by distention of connective-tissue interspaces (exudation cysts), *i. e.*, hydrocele, ganglion, and adventitious bursæ.

(*b*) By distention of mucous membrane canals, *i. e.*, hydro-salpinx, dilatation of vermiform appendix, etc.

(*c*) By dilatation of ducts and glands (retention cysts), *i. e.*, sebaceous cysts, ranula, spermatocele, and most of the cysts of the breast.

(*d*) By distention of normally-closed follicles in glands, *i. e.*, Graafian follicle cysts and some cysts of the thyroid gland.

(*e*) By dilatation and cutting off of portions of blood and lymphatic vessels.

(*f*) By encapsulation of extravasations of blood, foreign bodies, and parasites, *i. e.*, arachnoid cysts, hæmatomata, hydatids, etc.

(*a*) The application of the term cyst to many cavities abnormally distended with fluid is purely arbitrary and founded on custom. Thus, among the first division, hydroceles are not usually described as cysts, although they are technically quite as much so as a dilated bursa patellæ. Among other examples of this class is the common ganglion, which is formed by distention of diverticula from the tendons of the dorsum of the hand and foot. Adventitious bursæ result from separation of connective-tissue bundles by exudation, the cavity becoming lined with endothelium.

(*b*) Hydro-salpinx or distention of the Fallopian tubes by fluid, and disten-

tion of the vermiform appendix, are familiar examples of cysts formed by dilatation of mucous canals.

(*c*) The cysts resulting from retention of secretion in normal ducts and in glands, or *retention cysts*, constitute surgically the most important group, of which the common wen or sebaceous cyst is an example.

*Sebaceous Cysts.*—These are most common in middle life, and their seats of predilection are the scalp, back, shoulders, and face. They are rounded or lenticular, fairly movable, and situated immediately beneath the skin, to which they are often adherent. Upon their surface the blackened orifice of a dilated hair follicle may often be seen, and down this a fine probe may, in many cases, be passed into the cyst. The contents are a yellowish curdy material, either inspissated or semi-fluid, and showing, under the microscope, fat globules, fat crystals, and epithelial cells undergoing fatty degeneration.

Microscopically the walls are composed of an external coat of connective tissue lined internally with epithelium. The outer layers of cells are elongated and vertical; as the inner surface is approached they become flattened, undergo fatty degeneration, and finally form laminæ. The cysts are probably formed by dilatation of the hair follicle with sebaceous secretion and epithelium, and not of the sebaceous gland or its duct. They not infrequently become inflamed and suppurate, and occasionally calcify; they may also become the seat of secondary growths which spring from their internal surface, namely—papillomata, horns, and epitheliomata.

The diagnosis of sebaceous cysts rarely presents any difficulties except from dermoid cysts. The latter can be distinguished by the fact that they lie beneath the deep fascia, and the skin is therefore freely movable over them, while sebaceous cysts lie within the corium and are therefore attached to the skin. The situation of the cyst, age of patient, and other circumstances of the case may also assist in forming a diagnosis.

*Mucous Cysts.*—Retention cysts occur on mucous membranes from dilatation of the follicles. They are met with on the inner surface of the lip, base of tongue, and on the floor of the mouth. Dilatations of Bartholini's glands on the female vulva, and very rarely of Cowper's glands in the male, may call for surgical interference.

*Ranula* should also be classed in this group, it having been shown to be due to dilatation of one of a pair of mucous glands lying beneath the mucous membrane of the mouth on each side of the tip of the tongue. They are known as the glands of Blandini and Nuhn. Ranula presents itself as a fluctuating swelling, covered with translucent mucous membrane, which projects from the floor of the mouth beneath the tip of the tongue, and extends backward for some distance on one or the other side. The cyst may attain the size of a pigeon's egg. On opening it a glairy, fluid-like egg-albumin issues from it. The fluid is rich in mucin, but does not possess the characters of saliva, since it does not give the test for sulpho-cyanogen and is incapable of transforming starch into maltose.

A cystic dilatation of Wharton's duct itself was actually demonstrated in a case by Richet, but there can be no doubt that the ordinary ranula originates in the glands of Blandini and Nuhn. [In every case which has fallen under my personal observation, the cyst has originated by an obstruction of the ducts of *Rivini* (sub-lingual), and not of the glands of Blandini.]

Dermoid cysts occur in the same situation as ranula, and can only be differentiated from them by the nature of their contents.

Retention cysts of glandular organs will be described in other parts of this work. I will only allude to the fact that in the breast, and perhaps in a less degree in the testis and kidney, they may be roughly divided into three classes:—

1. Evolution cysts due to anomalies of development—illustrated in the breast.

2. Cysts occurring in middle life resulting from sclerosis and chronic inflammation; these are observed also in the breast and kidney.

3. Involution cysts accompanying the atrophy of senility in each particular organ and observed in the breast. I have also shown that spermatocele may be produced by the same process.*

(*d*) Cysts of the Graafian follicles at times resemble retention cysts, in that they are prevented from rupturing by adhesions, the result of peri-ovaritis.

(*e*) Cysts formed by cutting off of portions of blood-vessels are rare, and are found in connection with veins, especially the internal saphena; one case has come under my own observation. Virchow records an example in connection with the internal jugular vein. A case of cystic dilatation of the lymphatic vessels of each groin, in a youth aged twenty, has been described by Trélat. The swellings had existed six years.

(*f*) Cysts formed around extravasations of blood, foreign bodies, and parasites, are practically of the same nature, the encapsulation being due to the formation and organization of granulation tissue. In illustration of the first I may allude to a very large and distinctly defined blood-cyst of the scrotum, which I described. It followed a kick and had existed sixteen years. Butlin has pointed out that many cysts formerly described as blood-cysts were probably soft sarcomata into which profuse extravasation of blood had occurred (*hemorrhagic sarcoma*).

*Proliferous Cysts.*—Many cysts, especially those of glandular organs and mucous membranes, may become the seat of solid growths, which spring from their inner surface. They occur frequently in cysts of the lacteal ducts, and the disease then constitutes the true *sero-cystic disease* of Brodie. The intra-cystic growths are softish and papillary on the surface. Under the microscope they usually show papillæ, between which gland-like tubules, either rectilinear or tortuous, extend downward and give to the mass the appearance of an adenoma with scanty intercellular substance. Such cysts are usually innocent, but at times the growth is cancerous and infiltrates the surrounding tissues; it then constitutes the disease described as *villous cancer*.

Proliferous or papillary cysts are also common in the hilum of the ovary and broad ligament. They have essentially the same structure, being composed of tubular glands lined with columnar or cuneiform epithelium, and their surface is more or less distinctly papillary. They secrete mucus freely.

Such papillary and adenomatous intra-cystic growths are homologous to warts on the integument.

## II. CONGENITAL CYSTS.

Cysts originating in persistent rudiments of fœtal structures and congenital cysts.

1. *Cysts formed in the Remains of the Wolffian Duct and Body in the Female.*—These were first systematically described by Dr. Coblentz in Virchow's *Archiv*, Bd. 5, 1881. In ruminants and some other mammals the whole of the Wolffian body and duct persists. But in the human female only the anterior or sexual portion is normally present; it lies in the broad ligament, being known as the parovarium or organ of Rosenmüller. It consists of twelve or fifteen narrow, vertical tubes about half an inch in length, which radiate upward from the hilum of the ovary to join a horizontal tube running nearly parallel with the Fallopian tube. These vertical tubes represent the anterior or sexual segment of the Wolffian body; a few similar tubes are in rare instances found between these and the uterus, and are remnants of the posterior non-sexual segment. The horizontal tube, known as Gärtner's duct, is the duct of the same organ; it passes from the broad ligament into the side wall of the uterus, down which it courses into the anterior wall of the vagina, where it is usually lost. Wolffian remains also extend into the tissue of the hilum of the ovary, and in horizontal sections of that organ are seen as tortuous rods or columns of epithelium. This portion of the gland

* See "Catalogue of St. Bartholomew's Hospital Museum," Nos. 2807 and 2808.

is named the paroöphoron, while the ovarian tissue proper is spoken of as t
oöphoron.

All remnants of the Wolffian body and its duct give rise, by distention, cysts, and the great majority of these, according to Doran, contain papilla proliferous growths. They are conveniently classified as—

(*a*) Hilum cysts, which spring from the hilum of the ovary, and are disti guished from cysts of the oöphoron by having a layer of true ovarian tissue spre over their free surface. They often contain papillary intra-cystic growths.

(*b*) Broad ligament cysts. These arise from the normally persistent vertic tubes or parovarium, and sometimes in Gärtner's duct. The cysts lie betwe the layers of the broad ligament, which is usually evenly expanded. Tl Fallopian tube courses over their upper surface, and is much stretched if th attain a large size. They contain a clear, watery fluid, but sometimes the conten are discolored by hemorrhages. In larger cysts an epithelial lining rarely exist but in smaller ones columnar or columnar-ciliated epithelium may be found.

2. *Cysts of Müller's Duct.*—A small cyst, known as the hydatid of Morgagn is attached to one of the fimbriæ of the Fallopian tube in the female and to tl head of the epididymis in the male. It represents the terminal end of Müller duct in the female and in the male, but is of no clinical importance.

A remarkable instance of persistence of Müller's duct on one side in its whol length has been described by Dr. Ord. The dilated duct formed an elongate cyst extending from the right kidney to the sinus prostaticus.

3. *Cysts from the Urachus.*—Among other rarities, mention may be made c cysts arising in the persistent urachus. Some are lined with ciliated columna epithelium and others with hair-bearing skin; they may attain a great size. Cas have been observed in which the cyst communicated with the bladder, and th circumstance has given rise to the passage of hairs with the urine when the cy was dermoid.

Cysts have also been known to develop in Meckel's diverticulum, from t blocking up of the intestinal end.

4. *Dermoid Cysts.*—These cysts are found in connection both with skin a mucous membrane and in various internal organs. A dermoid cyst must, therefo be defined as a cyst lined with skin or with mucous membrane and of congeni origin. They may conveniently be divided into: (*a*) Dermoids derived from e blast by *enclavement*. (*b*) Dermoids of internal organs.

(*a*) The first group comprises dermoid cysts of the skin, mouth, rectum, a nerve-centres, and those situated near the median line in the thoracic and abdo mal cavities. They are all produced by cutting off of a portion of epiblast (*encla ment* during the process of closure of branchial fissures of the body walls in t middle line, and in the formation of the membrane bones of the skull and fa They also occur in connection with the involution of epiblast to form the mou genito-urinary apertures, rectum, the eye and ear, and the brain and spinal co

(*b*) The second group include dermoids of the ovary and testis, and perh may be attributed to exceptional formative powers and tendencies to variation the structures from which these organs arise. But since the Wolffian duct l recently been shown to be of epiblastic origin, the possibility suggests itself th these cysts may also be derived from the epiblast.

**Distribution.**—On the head and face they are more often situated over t lines of sutures. Their commonest site is beneath or near the eyebrow, especia toward the outer side, but they are also found at almost any part of the orbi margin. On the skull they are most often observed in the temple near the fron maxillary suture, in the anterior fontanelle and over the mastoid process; l they may exist at any part. On the face they occur over the middle line of t nose, the fronto-nasal suture, on the cheek, on the neck they are plac laterally, over the ear, the gland, near the angle of the jaw and along t anterior margin of the sterno-mast[illegible] in lines corresponding to the lines of t fetal fissures of the [illegible] are median, being commonest here bene

the hyoid bone (sub-hyoid cyst). Those of the skull and orbital margin are always deeply placed and attached to the periosteum. They often lie in a depression in the bone, which may even be perforated; or the cyst is placed entirely within the skull. In the College of Surgeons' museum is a parietal bone perforated at its centre; from the aperture a dermoid cyst was removed and the patient died of meningitis.

Some dermoids near the angle of the jaw and along the sterno-mastoid have deep connections attaching them to the styloid process and sheath of the carotid vessels.

Cysts formed during the closure of the body walls are observed, especially near the junction of the first and second bones of the sternum and near the umbilicus; also in the thoracic and abdominal cavities and even in the lung itself. In connection with the development of the central nervous system, dermoids occur in the brain and over the spine. They are fairly common over the sacro-coccygeal region, constituting one of the varieties of congenital sacral tumor.

Precisely similar cysts are also generally distributed. I have met with two over the scapula and one near the breast. They exist as rarities in the limbs. Those of the digits are often due to implantation of epithelium by wounds.

The dermoids of the ovaries are situated within the oöphoron; those of the testicle within the tunica vaginalis, and sometimes are enfolded by the parenchyma of the gland.

Dermoids found in various parts of the abdominal cavity are often of ovarian origin, having become separated by twisting of their pedicles.

**Structure.**—The dermoid cysts included in group (*a*) are usually simple in structure. They have a lining possessing the microscopic characters of skin, which shows the normal arrangement of the epidermis with papillæ. Some are devoid of both hairs and glands; others are furnished with hairs and sebaceous glands, while in a smaller number the wall also contains sudoriparous ones. The contents are fatty matter, of oily, honey-like, or buttery character. This is derived from degenerated cast-off epithelium and from the secretion of sebaceous glands. Microscopically it shows epithelium and crystals of margarin and cholesterine. Similar cysts to these form a large proportion of group (*b*), *i.e.*, dermoids of internal organs, not apparently connected with epiblast. Cysts of the same nature as dermoid are found in the floor of the mouth, in the neck and omentum; they are lined with pavement or with columnar-ciliated epithelium, and may conveniently be described as mucoid cysts. I have examined a sublingual cyst from John Hunter's collection, of this nature. Some of the cysts of the neck are covered on one side by skin and on the other by mucous membrane, indicating that the lining was derived from the epithelium on each side of a branchial cleft. They may even open externally, like a persistent branchial cleft. Complex dermoid tumors occur in the ovary, scrotum, sacro-perineal and maxillary regions, in the thorax and abdomen, and, in one instance, in the orbit. Many of them are included in the group of congenital tumors to which the name of teratomata has been given. They are for the most part cystic, or solid. The cysts are respectively lined in varying proportions with skin and with mucous membrane. Those having an integumental covering present the ordinary features of dermoids; and in the ovary and elsewhere may contain hair, teeth, nails, and overgrown sebaceous glands, which even reach the complexity of a mammary gland. The cysts are embedded in a stroma of young or of mucoid connective tissue in which may be found in varying frequency plates of bones, cartilage, unstriped and, very rarely, striped muscle, with nervous elements of various kinds, *i.e.*, uni- and multi-polar cells, medullated fibres and fibres of Remak. Further, traces of organs may exist as lungs, intestine, eye, and lymphoid tissue. In the sacro-coccygeal and maxillary regions a complete series of transitions between dermoid cysts and parasitic fœtuses has been observed.* Bland

* I have suggested that the complexity of these tumors depends on the period of embryonic life and the extent of the blastoderm involved in the disturbance, the tumor being more complex the earlier the disturbance.

Sutton has sought to connect the origin of certain simple and complex dermoids with some fœtal canals, as the infundibulum, the hyo-lingual duct, and the neuro-enteric passage.

**Period of Origin.**—The nucleus of all dermoids is congenital, with the exception probably of some cysts of the ovary. Cutaneous dermoids do not usually appear till puberty, and this circumstance may be connected with the accelerated activity of the skin, shown by the development of the hair in certain parts.

Dermoid cysts and tumors of the ovary are commonest between fifteen and thirty years of age.

They occasionally become the seat of epithelioma and of sarcoma.

A few instances have been recorded in which dermoid cysts of the ovary have been ruptured, and their contents, escaping, have become implanted on the omentum and peritoneum and have given rise to small secondary cysts of the same nature.

5. *Congenital Hygroma.*—These tumors of infancy are most commonly situated on the neck and gluteal region, and less frequently in the axilla, on the arm, thigh, and cheek. Like other cystic tumors, the proportion of solid tissue and cyst varies greatly. The tumor may be chiefly composed of numerous intercommunicating loculi embedded in gelatinous connective tissue, or may be for the most part solid, the cyst spaces being small and scattered; exceptionally it is composed of one large cyst. The cavities are loculated, their walls are smooth and rendered irregular by imperfect septa. Their contents are serous fluid, in some instances sanious, rarely creamy, and rich in cholesterine. The tumors always lie beneath the deep fascia, and tend to spread widely in an irregular manner between the muscles, even infiltrating their substance. In the neck they occupy the front or lateral aspects; they are often attached to the sheath of the large vessels and may extend upward behind the pharynx to the base of the skull, downward beneath the deep fascia into the thorax, or into the axilla. The loculi and spaces are lined with an endothelium, the borders of which are irregular, but not dentated in the manner peculiar to lymphatic vessels. In some instances their walls are surrounded by a layer of unstriped muscle fibre. The stroma in growing portions of the neoplasm has the characters of embryonic connective tissue. When the morbid growth infiltrates muscle or a gland, striped muscle and epithelium may respectively be found in it.

The pathogeny of these tumors is still somewhat doubtful. The form, lining, and nature of the contents of the loculi point to their being a variety of lymphangeioma. They originate at a very early period of intra-uterine life, probably the fourth or fifth month.

**Symptoms.**—They may merely give rise to inconvenience from their size, but in the neck often cause serious symptoms from pressure on the trachea, the gullet, and large vessels.

**Treatment.**—Tapping may be resorted to with good effect when large cysts exist. Setons have been used for the purpose of setting up suppuration and inducing occlusion of the cysts in that manner. Tincture of iodine may also be injected for the same purpose. But these means are attended with the danger of setting up cellulitis. The safest method is excision. This operation should not be lightly undertaken, since it is attended with much difficulty and danger, owing to the deep expansions of the growth and the displacement and matting together of important structures. Electrolysis has also been employed, but not with satisfactory results.

## SOLID TUMORS.

### Fibromata.

Fibromata are tumors composed of adult or well-developed fibrous tissue. They form distinctly circumscribed, encapsuled, movable masses, which are either lobulated or uniform in outline. They also occur as pedunculated subcutaneous

tumors (molluscum fibrosum) and as polypoid growths from mucous membranes. In consistence they vary from a density approaching that of cartilage to a succulent, yielding, but still not friable tissue. Fibromata of the labia majora and pedunculated fibromata of the skin are often extremely succulent, and large quantities of serum exude from them on section; this variety was formerly described as the fibro-cellular tumor.

A section of the firmer fibromata displays a number of outstanding fibrous bands on a gray, yellowish, or opaque white ground, or the section is firm, uniform, and dull white. The fibres either interlace, are arranged concentrically, or in parallel lamellæ. A scraping yields no juice. Microscopically the firmer tumors are composed of looser or more compact bundles of fibres, often wavy and interlacing, or disposed chiefly parallel to each other (Fig. 16). Situated on the bundles, in small numbers, are flattened nuclei of connective-tissue cells, the protoplasm of which may be demonstrated to anastomose by processes around the bundles. The softer forms are made up of interlacing fibrillæ, more or less thickly studded with large round or oval connective-tissue cells, whose protoplasm is continuous with the fibrillæ.

As varieties, fasciculated and lamellar fibromata have been described.

In some of the laminated fibromata layers of connective tissue are concentrically disposed around blood-vessels and nerves. When a nerve and its branches are involved, as, for example, the pes anserinus, a very curious tumor composed of tortuous anastomosing cylinders (plexiform neuro-fibroma) of fibrous tissue is formed. The fibrous nodules of cartilaginous density found on the pleura and in the capsule of the spleen are examples of laminated fibromata in which the laminæ are arranged parallel to the surface.

The distribution of the fibromata is exceedingly general, for they occur wherever connective tissue exists, the following being the chief sites: the skin and subcutaneous tissue, fasciæ, capsules of joints and synovial fringes, the nerves, the nose, gums, the periosteum of the lower jaw, ovary, round ligament, and breast.

*Painful Subcutaneous Tubercle.*—These tumors are situated in the corium or subcutaneous tissue, are rounded, rarely exceeding half an inch in diameter, and are usually single. They occur with much greater frequency on the lower extremities, and are more common in women than in men. Insignificant in themselves, they attract attention from the severe darting pain to which they give rise, sometimes associated with extreme tenderness. Probably in many cases the pain is much exaggerated by hysteria or allied conditions.

The precise relation of these fibromata to nerves is still a matter of question. Many observers have failed to find any connection with a nerve, while in other cases nerve-filaments have been traced into the tumor or found spread out over its surface. And, in certain instances, the whole tumor has been stated to be composed of non-medullated nerve-fibres (Virchow).

A passing allusion may be made to the small fibromata which occasionally form around the punctures for ear-rings. They are notable from the fact that not rarely they recur after removal, but show no other sign of malignancy.

Fibromata may undergo mucoid metamorphosis and also calcification, the latter change being often observed in those connected with the jaw.

Friction or other forms of irritation may act as exciting causes: in two instances I have observed symmetrically-placed fibromata over the ligamentum patellæ.

They do not recur after removal, but their relations with the sarcomata are exceedingly close. At times the differentiation between fibroma and fibro-sarcoma is impossible without the microscope. And, again, a fibroma may exist for many years and ultimately develop into a sarcoma.

**Diagnosis.**—Fibromata are circumscribed, fairly movable, usually smooth, dense, but elastic and heavy. When pendulous and œdematous they are of soft and yielding consistence. Microscopically they exhibit adult fibrous tissue with

scanty cells, and at growing points it may be observed that the young cells are forming adult and well-developed fibrous tissue; while in the fibro-sarcomata the cell-elements are abundant and their transformation into fibrous tissue is incomplete.

### LIPOMATA.

Lipomata or fatty tumors resemble ordinary adipose tissue, except that the individual vesicles are often of larger size. They are *circumscribed* or *diffused*. The common circumscribed lipoma of the subcutaneous tissue is easily recognized by its lobulated or slightly irregular outline, its mobility, and its elasticity, which often approaches semi-fluctuation. The overlying skin, on being raised, is found to dimple slightly, owing to connective-tissue fasciculi which pass between it and the tumor. This shells out readily from a capsule of condensed connective tissue, and its surface is smooth, but deeply fissured and lobulated.

The trunk and especially the shoulders are the seat of election of lipomata; perhaps, it may be said broadly, the regions of the shoulder and pelvic girdle. But they are sometimes observed on the limbs, and I have seen two cases of multiple lipomata on the arms of women.

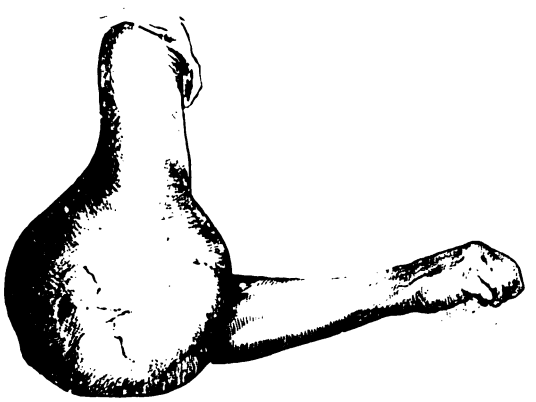


FIG 13.—Fatty Tumor of 37 years' growth on arm of woman, æt 69.

FIG. 14—Diffused Lipoma of Neck.

They also form between muscular planes, in the tongue, uterus, walls of stomach and intestines, in the scrotum around the tunica vaginalis, in connection with the periosteum of the skull and other bones, and with the sheaths of blood-vessels. Appendices epiploicæ may enlarge and constitute tumors. Masses of fat connected by a pedicle with the peritoneum are also found protruding through the linea alba, and along the inguinal canal into the scrotum, where they simulate omental herniæ.

Age exercises a marked influence on the formation of lipomata; middle life, when adipose tissue is accumulating, being that in which the great majority occur. But cases of congenital lipoma are not very rare. The parts affected chiefly are the sacro-coccygeal region, perineum, neck, and back; and the formation of fat may be associated with congenital hypertrophy.

Mechanical irritants, as carrying weights on the shoulder and back, are exciting causes; and it would appear in such cases that an irritative new formation of connective tissue undergoes fatty transformation.

**Degenerations.**—Lipomata undergo softening or oily change; and, in tumors of long standing, the connective-tissue septa may become calcified. Very large and, especially, pendulous tumors are subject to ulceration of the dependent

The name cancellous sufficiently describes the structure of the third variety, the most common and widely distributed of all. With rare exceptions they are situated on the diaphyses of the long bones, near to, but not necessarily over, the epiphysial disc, and are covered with a layer of cartilage, the deeper surface of which grows continuously and is converted into bone. This fact, and their situation, leave no room for doubting that they originate from aberrant portions of the epiphysial disc which have not been converted into bone. Genetically they are therefore closely allied to the enchondromata of bones. I have observed that such exostoses are more common in rickety subjects. At times they are multiple, affecting all the long bones of the skeleton; and in such cases, like the multiple enchondromata, they cease to increase in size after the completion of growth. A marked hereditary tendency often exists. The distal phalanx of the great toe beneath the nail is a common site for exostosis.

These osteomata should not be confounded with exostoses formed by ossification of the attachments of tendons and muscles, such as occur in connection with the adductor magnus, the psoas and iliacus, or the deltoid.

Lastly, osteomata are in rare instances found altogether unconnected with bone—in the subcutaneous tissues, for example, of the buttock or thigh.

Masses of bone are also formed in the gracilis and deltoid muscles, but these can hardly be considered as true tumors, being, perhaps, the result of inflammation or over-use. Those which occur in the adductor longus are known as "rider's-bone," because they are met with in cavalry soldiers and rough-riders.

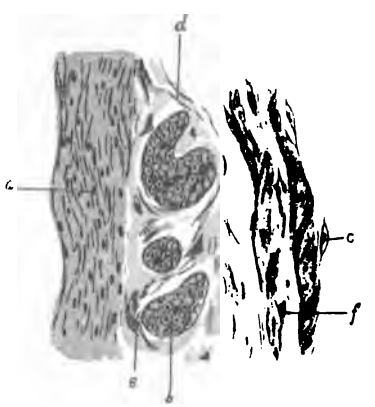



FIG. 17.—Non-striped Myoma (Uterine Fibroid). Stained with Picro-carmine. (× 450.)

*a*. Mass of non-striped muscular tissue, in which the rod-shaped nuclei and the parallel arrangement of the fibrils are seen; *b*. Similar bundles of fibres cut transversely. The sections of the fibrils have the appearance of rounded cells, the section of the round nucleus is seen as a dot in *some* of the sections; *c*. Spindle-shaped cells, of which the fibrils (*f*) are composed; *d*. Pink fibrous tissue; *e*. Connective-tissue corpuscles. (*After Woodhead.*)

## MYOMA.

[Myoma is a tumor composed of muscular tissue. There are two principal varieties: One, composed of striped muscular tissue, very rare, termed Rhabdo-*myoma*, and the other of unstriped muscular tissue, and is termed Leio-myoma. The latter is the more common form, and may be found in any organ in which unstriped muscle-tissue is a normal constituent. The uterus, the wall of the bladder, the prostate, and the kidney are the most common seats of the leio-*myomata*. When in the uterus, the myomata are designated according to the [illegible] as *intra-mural*, *submucous*, and *subserous*.]

### Myo-Fibromata.

Myo-fibromata, as the name implies, are composed of muscle and fibrous tissue, in varying proportions. The muscle presents the ordinary characters of the unstriped or involuntary variety, and is distributed in interlacing fasciculi. The outline of individual fibres often is not easily distinguishable in sections, but the fibres may be readily isolated by teasing after hardening in chromic acid. In some growths of long duration the fibrous tissue preponderates. The naked-eye characters resemble those of a coarse fibroma, the section being marked by distinct interlacing fibrous bundles. The growth is well-defined, and can usually be enucleated without difficulty.

Degeneration—either mucoid, fatty, or calcareous—is not uncommon, and patches of softening or collections of serum, forming cysts, may develop within them. They occur in almost all structures containing unstriped muscle; with great frequency in the uterus; in the œsophagus, intestine, bladder, testicle, ovary, round ligament, and in the prostate, in which they constitute the chief portion of the common enlargement of that organ. Their growth is slow, and clinically they are benign. Spindle-celled sarcoma, which also occurs occasionally in the uterus, can often only be distinguished with great difficulty from myo-fibroma.

### Angeioma.

Under this name are included nævi, cavernous tumors, and aneurism by anastomosis.

Nævi, or "mother's marks," are tumors composed of convolutions of dilated capillaries lying in the corium and subcutaneous tissues. They are always congenital, and at birth may exist as a tiny red or purplish speck, which spreads more or less rapidly. As a rule, the growth is exceedingly slow, and it may be questioned if, in a large number of cases, the increase much exceeds that of the surface of the skin. Their fate, if left alone, has not been carefully studied: some shrink and wither, others appear to become warty, papillated, and deeply pigmented. In one case which I observed a nævus of the ear developed into an aneurism by anastomosis. Superficial nævi—those, that is to say, that involve the corium—appear as bright red, or purple, and slightly raised patches. Deeper ones, lying subcutaneously, form rounded, rather ill-defined, doughy, or spongy tumors, which diminish in size on pressure, and communicate a bluish tint to the superjacent skin. Many nævi involve both skin and subcutaneous tissue. The superficial form is usually described as a capillary, the deeper as a venous or cavernous nævus, but no distinction as regards their minute structure can be drawn between them; both are made up of tortuous anastomosing capillaries, usually only moderately dilated. A section through a subcutaneous, or so-called venous or cavernous, nævus exhibits a number of whitish, firm, fat-like lobules, united by connective tissue, showing to the naked eye few indications of its real structure. In rare instances the capillaries become so much dilated as to form cavernous sinuses, but this is certainly the exception.* The capillaries of nævi are lined with a layer of plump endothelium, and bounded with a thin lamina of connective tissue; they are usually closely approximated and are supported by connective-tissue trabeculæ rich in nuclei. Hair follicles, sebaceous and sudoriparous glands are interspersed.

The treatment of these growths is detailed elsewhere.

*Cavernous angeiomata* are met with in the liver, kidneys, and in the walls of the intestines; in a leg which I dissected numerous cavernous tumors were situated along the course of the large veins. They are composed of large venous sinuses separated by narrow connective-tissue trabeculæ. Aneurisms by anastomosis are rare and are usually situated on the scalp. They have an expansile pulsation, and their surface is irregular from the projection of tortuous dilated arteries. One,

* A good example of this is in the Royal College of Surgeons' Museum, No. 407.

which I injected and examined, involved the whole pinna of a young woman, and was entirely composed of a very delicate net-like anastomosis of minute arterioles.

[The editor has seen a very large congenital aneurism by anastomosis, in a child of two years, which involved the penis and entire scrotum.]

### Lymphangeiomata.

These are to the lymphatic vessels what nævi are to the blood-vessels, and, like the latter, are congenital. Tumors composed solely of dilated tortuous lymphatic channels have been described, but usually fibrous hypertrophy of the affected part is associated with many dilated and tortuous lymphatics, as, for example, in macroglossia. I have observed considerable dilation of the lymphatics in congenital hypertrophy of the hand and foot.

Congenital hygroma of the neck, as pointed out already, is probably a form of lymphangeioma.

### Neuroma.

The great majority of tumors classed under this heading are simple fibromata springing from the peri- or endo-neurium. They are either merely embedded in the nerve-trunk or form nodular thickenings of it, and even individual fasciculi of the trunk may present minute bead-like enlargements. It is not rare to meet with cases in which nearly all the nerve trunks of the body are studded with fibro-neuromata. Occasionally these neoplasms are associated with molluscum fibrosum of the skin. Rare instances of true neuroma, composed of convoluted bundles of medullated nerve fibres have been recorded, and Virchow has described tumors composed of delicate threads, which he regarded as amyelitic fibrils. Myxo- and spindle-celled sarcomata also occur in nerve trunks, and it may be noted that it would be difficult to distinguish histologically the latter from developing nerve fibres.

### Sarcomata.

Sarcomata are tumors derived from the connective-tissue constituents of the body, but their elements never develop into fully-formed or adult structures; they are always arrested at some intermediate stage in the formation of the various connective tissues, as fibrous tissue, bone, or cartilage. Their elements are, therefore, often described as embryonic, and they are spoken of as embryo-tissue tumors. This name implies a theory which is both misleading and untrue. It is misleading because an inference is apt to be drawn that these tumors originate from embryonic rudiments of connective tissues, whereas by far the majority originate in adult life, and, as far as we know, from adult tissues. It is also untrue, because certain sarcomata, as the spindle-celled, have no counterpart in the connective tissues of the healthy embryo. The true prototype of the various forms of sarcoma may be found in the transitions of granulation cells to form fibrous or scar-tissue and callus, and clinical evidence abounds indicating that many of the sarcomata of later life have an inflammatory or irritative origin. On the other hand, many of those observed during the first five years of life may, with much probability, be referred to an irregularity in or arrest of development.

The sarcomata are divided into three chief varieties, the round-celled, spindle-celled, and myeloid. Between these many intermediate forms are observed; thus, round and spindle-cells may be mingled in nearly equal proportions—*mixed sarcoma*; and myeloid cells are associated either with round or with spindle-cells. Again, the spindle-celled sarcomata shade off indefinitely into the fibromata (see *Fibro-sarcomata*).

*Round-celled Sarcoma.*—These again are divided into two sub-varieties, the small and the large. The former is much the commoner, and its component cells are about the size of leucocytes or granulation cells. In the latter they are as large as those of squamous epithelium. A section of a round-celled sarcoma under the

microscope shows a *uniform* surface formed of closely-crowded cells, perhaps intersected here and there by a band of connective tissue. In this respect and the character of the cell it differs essentially from cancer. The nuclei are large and the protoplasm around them scanty; in fact, many of the small round-celled tumors appear to be composed almost entirely of nuclei, in many of which evidence of nucleus division (karyokinesis) may be demonstrated with appropriate reagents. The intercellular substance varies; it is usually scanty and homogeneous, sometimes formed of delicate interlacing fibrillæ prolonged from the protoplasm of the cells, and sometimes of homogeneous bands. The blood-vessels are usually abundant, and in many instances have no proper wall. They are lined with rounded endothelium, which rests directly upon the cells of the tumor. Hence, they often become dilated or rupture and form blood-cysts, which give rise in tumors of bone to pulsatile expansion.

*Spindle-celled sarcomata* are composed of either small or large spindle-cells analogous to the fibro-blasts of young granulation tissue; they possess an oval nucleus, and their extremities are prolonged into a more or less delicate fibre.

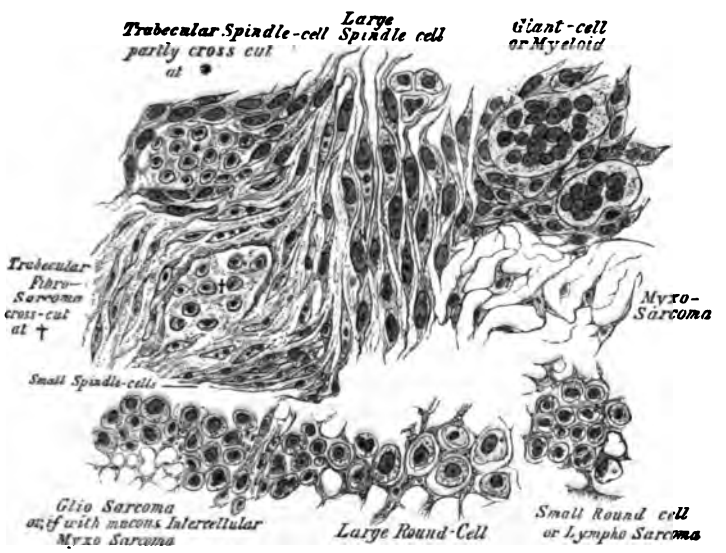

Trabecular Spindle-cell partly cross cut at *
Large Spindle cell
Giant-cell or Myeloid
Trabecular Fibro-Sarcoma cross-cut at †
Myxo-Sarcoma
Small Spindle-cells
Glio Sarcoma or if with mucous Intercellular Myxo Sarcoma
Large Round-Cell
Small Round cell or Lympho Sarcoma

FIG. 18.—Sarcoma.

The cells are closely approximated, and are arranged in parallel or intersecting fasciculi or bundles. Many spindle-celled sarcomata show a partial transformation into fibrous tissue. The protoplasm of the cells unites to form a coarse stroma, only the elongated nuclei remaining visible, as may be observed, in many sub-periosteal tumors of bones; or the protoplasm is prolonged into filaments which unite in fasciculi (fibro-sarcomata). Such tumors can only be distinguished from fibromata by the large number of nuclei present, the imperfect development of the fibrous tissue, their succulence, and relatively rapid growth.

*Myeloid sarcomata* occur almost exclusively as *central* tumors of bones—rarely sub-periosteal—and in the gum as epulis. They are characterized by the presence of irregular multi-nucleated masses of granular protoplasm (giant-cells), the physiological prototype of which is the osteoclast. They are associated either with round or spindle cells, or both, and transitions from the round to giant-cells may be observed (Fig. 18). A section has, in parts or over the whole surface, a peculiar maroon-red tint, by which the nature of the tumor may be recognized.

Many sarcomata of bone undergo partial transformation into cartilaginous or

osseous material. In the former (chondro-sarcoma) the intercellular substance is abundant and hyaline, and becomes chondrified.. The latter (calcifying or osteo-sarcomata) are composed either of round or spindle cells. The round cells are enclosed each in a mesh of a delicate fibrous reticulum in which lime-salts are deposited. The process is analogous to the calcification of the imperfectly formed fibrillar matrix of bone sometimes observed in rickets, and in callus. In osteo-sarcoma the secondary growths in lymphatic glands and internal organs are also calcified.

*Myxo-Sarcoma.*—Some tumors of the breast, parotid gland, testicle, and rarely of the periosteum, have a white, translucent, gelatinous aspect, due to mucoid metamorphosis. Under the microscope they show, in varying proportions, branched and round cells, which stand out distinctly in an abundant homogeneous stroma (Fig. 18). Only a portion of the growth may have undergone this change, the remainder being composed of ordinary round or spindle-celled tissue.

*Alveolar sarcoma* is another sub-variety, clinically unimportant, and is found in bone, muscle, and subcutaneous tissue. The cells are large, round, and not unlike epithelium; they form either small masses in alveoli, bounded by delicate bands of fibrous tissue; or, more often, each cell is enclosed in a mesh of fibrous network.

*Melanotic Sarcoma.*—These present characteristics pathologically and clinically midway between the sarcomata and carcinomata. They, for the most part, originate in moles of the skin and in the choroid of the eye, and have also been observed on the vulva, hard palate, and growing from the matrix of the nail. They are extremely common in white horses. In color they are black or sepia-brown; and a section may be pigmented uniformly or only in small parts, the remainder resembling medulla. Histologically they usually have a more or less marked alveolar structure, the stroma being scanty. The cells in cutaneous tumors are round or irregular from pressure, often of large size, and may have an epithelial aspect; they are sometimes mingled with spindle cells. The tumors of the choroid are commonly composed of spindle cells.

The pigment is deposited in granules within the cells; and, to a smaller extent, lies free in the stroma.

Individual cases of melanotic sarcoma vary greatly in malignancy. In the majority, the prognosis is exceedingly bad. Shortly after the appearance of the tumor, small, pigmented, secondary nodules are seen in neighboring parts of the skin, and the nearest lymphatic glands become affected, the growth sometimes extending directly in lines along the lymphatic channels. Within a brief space dissemination takes place in internal organs, the liver being a favorite site for them; and, in some instances, the skin over the whole body is dotted with the growths. On the other hand, melanotic tumors, having the same general appearances, may grow slowly, and not recur even after a tardy removal.

From the foregoing account it may be noted that the melanotic sarcomata of the skin closely approach the cancers, in that they possess an alveolar structure, often an epithelioid type of cell, and in the fact that they originate in connection with a structure—the skin (itself pigmented)—derived from epiblast. And further, as in cancers, the lymphatic glands are early affected. It may subsequently be shown that those attributed to the choroid really spring from the pigmentary layer of the retina, which is also of epiblastic origin.

I have myself observed in two instances melanotic tumors continuous with tap-like ingrowths of the epidermis, as in epithelioma; and for these reasons am impelled to believe that these tumors are really, in many instances, cancers originating in patches of imperfectly developed skin, such as moles.

*Simple, Circumscribed Melanotic Masses.*—A very remarkable and rare disease has been described under this name, in which innumerable, well-defined masses of black pigment are formed simultaneously in many organs and structures. The primary focus of infection often cannot be ascertained. The nodules vary in dimension from a microscopic grain to the size of an egg or fist, and are observed

in the subcutaneous tissue, peritoneum, breast, and in the muscular substance of the heart. The pigment-granules constituting the masses accumulate in the cells of the normal tissues, namely, in the connective-tissue cells, muscular fibres, and epithelium; these are destroyed, and the tissues are replaced by a nodule, or a tumor softened at the centre, there being no trace of a cellular new-formation, such as exists in melanotic sarcoma and cancer. The disease in man proves fatal in a few months; whilst in horses, in which it is common, its progress is slow.

*Lympho-sarcoma.*—This must not be confounded with lymphadenoma. It is a variety of round-celled sarcoma, originating in a lymphatic gland, extending by contact to a whole group and to neighboring chains, but never, like lymphadenoma, involving simultaneously the whole lymphatic system. The disease not unfrequently attacks the mediastinal glands, spreads along the bronchi into the lungs, and involves the pericardium. The morbid growth is medullary in character, but rather firm, and yields a milky juice. The microscopic structure presents a rough resemblance to the cortical portion of the lymphatic gland, the chief part consisting of lymphoid cells, arranged in rounded masses or in irregular cylinders lying in the meshes of a coarse, fibrous stroma. A reticulum, such as is found in lymphadenoma, does not exist.

*Glioma*, or *glio-sarcoma*, is a variety of connective-tissue tumor arising from the neuroglia of the brain, retina, and, in rare instances, the spinal cord. It is commonest in the retina of children, and springs probably from the granular layers. Retinal gliomata are composed of small round cells, united by a scanty homogeneous or fibrillar intercellular substance. In those of the central nervous system the protoplasm of the cells gives off prolongations, which are continuous with a felting of delicate fibrils.

In the central nervous system these growths appear as white, or pinkish, ill-defined masses, firmer than the surrounding brain-tissue, into which they merge insensibly. Usually they are situated in the convolutions, and are solitary, but occasionally multiple. Although they possess the features of local malignancy, they do not give rise to metastasis in distant organs; in this respect, however, glioma of the retina is distinctly worse, being very prone to recur locally.

*Myo-* or *Rhabdo-sarcoma.*—Mixed tumors composed of round cells and striped muscles have been observed in infants or young children. They are adherent to and sometimes infiltrate the substance of the kidney, and in some instances have involved both organs. Similar growths occur in the testicle; and both striped and unstriped muscle not rarely are present in cystic sarcomata of that organ. In the rhabdo-sarcomata the muscle takes the form of transversely striated fibrils, or of elongated spindle-cells, also striated.

*Adeno-sarcoma.*—Certain sarcomata of glands, as the breast, parotid, and testicle, contain a variable amount of the normal gland-tissue distributed throughout their substance. The sarcoma-tissue originates in the stroma of the organ, expands and stretches out the gland-tissue, the epithelium of which must therefore grow to cover the increased surface, but otherwise there is probably no new formation. Certain of the ducts or gland-tubules are obliterated, and the intervening portions may be dilated, and form cysts, into which, in the breast and sometimes the testicle, rounded masses of sarcomatous stroma protrude. Adeno-sarcomata may be made up of almost any form of sarcoma-tissue; but the stroma is commonly composed of round or stellate cells with a large proportion of fibrillar connective tissue (Fig. 19.)

*Cylindroma.*—This name is given to peculiar neoplasms of rare occurrence, and mostly sarcomata. Their chief distinguishing feature is the presence of intersecting hyaline bands and cylinders, which are produced either by mucoid degeneration of strands of cells, or by greatly thickened blood-vessels, the sheaths of which have undergone hyaline change. The latter condition is more often observed in cerebral tumors. A somewhat similar appearance is met with in growths of nerve-plexuses, as the pes anserinus, in which the cylinders result from thickening of the endoneurium.

*Endotheliomata* are growths arising from the endothelial linings of various cavities of the body and of the blood-vessels. Endothelium being derived from mesoblast and belonging to the connective tissue, these growths must be included in the connective-tissue series.

*Psammoma*, or *angeiolithic sarcoma*, originates in connection with the membranes of the brain and spinal cord. It is characterized by the presence of spheres, usually calcified, resembling in structure and mode of formation the brain-sand of the choroid plexus. The spheres are united by fibrous tissue, and are sometimes arranged in a dendritic fashion. They are composed of very large and thin endothelial plates, disposed in concentric laminæ, and, according to Cornil and Ranvier, are formed by buds springing from the walls of blood-vessels, which are numerous. Presumably the cells are derived from the endothelium of the blood-vessels. In their clinical character these tumors are innocent.

*General Characteristics of Sarcomata.*—Great variations exist in their physical characters. The majority have a well-defined, rounded, and at times a largely nodulated outline, and many are distinctly encapsuled. Some of the softer, round-celled forms infiltrate like cancer. Their consistence includes every grade, from that of soft brain-tissue, or jelly, to that of a fibroma: in color they are creamy or pearly white, and often blotched with various shades of red, yellow, and brown, produced by changes in extravasated blood. The section is uniform, homogeneous, faintly fibrillar, or distinctly fasciculated. Some indication of the structure may be obtained from the naked eye character. Thus the round-celled growths are usually soft, medullary, or semi-gelatinous; the spindle-celled have a smooth, rather firm, homogeneous section, and a few faint, fibrous bands only can be traced on their surface, or they may be distinctly fascicular. The appearances of some of the special varieties have already been described.

Modifications result from the various forms of degeneration affecting a part or the whole of the mass, *i. e.*, mucoid, fatty, or caseous; or from hemorrhage and cyst-formation. When the skin gives way over a sarcoma it usually protrudes as a red, soft mass of granulation-tissue. The duration, progress, and malignancy of these tumors offer as much diversity as their physical characters. Soft, medullary, rapidly-growing neoplasms, and the melanomata, are the most malignant, sometimes killing, from generalization of the growth in internal organs, within a few months. At the other extreme the spindle-celled sarcomata of the skin and the fibro-sarcomata grow exceedingly slowly; but they are prone to recur near the cicatrix, again and again after removal, and five or six operations may be performed before the patient succumbs from exhaustion, or dissemination of the growth. Such tumors were formerly described as "recurrent fibroids." As regards prognosis, the rapidity of growth, consistence, and locality are of more importance than the microscopic structure. Of this it may broadly be said, that the elementary round and spindle-celled growths, especially the former, are more malignant than those in which there is an attempt to organize and form fibrous tissues.

Locality is a most important element, sarcomata of the testicle being, for example, much more malignant than those of the breast. Of tumors of bone, the myeloid are by far the least malignant—probably, in great part, because, being usually central, they are enclosed by an osseous capsule.

The mode of generalization of sarcoma differs essentially from that of cancer; in the former the blood-vessels are numerous, thin-walled, often mere channels in the growth, and thus the conditions are most favorable for the escape of its elements into the veins, whence they are carried into the heart, lungs, and other viscera; while, in the latter, secondary growths first appear in the nearest chain of lymphatic glands, and from these the tumor elements pass into the blood stream. But it is erroneous to suppose that the glands are never affected in sarcoma, for in growths of the testicle and tonsil it is the rule (Butlin). Glands are also often involved by contiguity, when the growth originates near them, as in tumors of the ilium. An outgrowth from a sarcoma may project into, and grow for a great

distance along, a vein. In a mixed-cell sarcoma of the forearm, I found a prolongation extending for some distance along, and occluding one of the veins at the bend of the elbow.

### Epithelial-Tissue Tumors.

This large and important group comprises tumors derived from the epithelium of the surfaces and glands of the body; and which, speaking broadly, originate from the epi- or hypo-blast. It need scarcely be remarked that these tumors are composed of both epithelium and connective tissue; in fact, in some, the latter preponderates, as in contracting scirrhus; but it is the epithelium which takes the initiative in growth, and gives to the tumor its special character.

These neoplasms are divided clinically into two groups—the innocent and the malignant. To the former belong papilloma and adenoma, to the latter carcinoma.

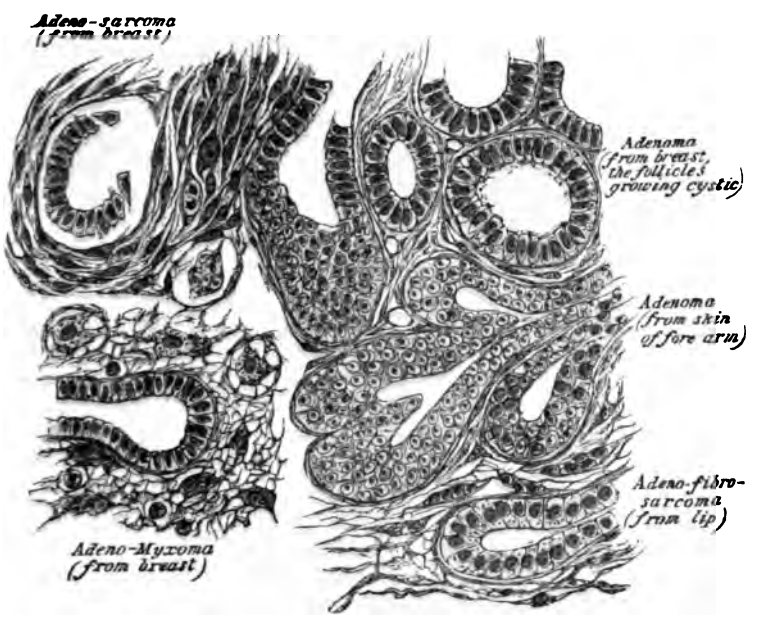



Fig. 19.—Adenoma.

### Papillomata.

The simplest are merely overgrowths of the normal papillæ of the skin or mucous membrane, each consisting of a central stem of connective tissue, containing capillaries, and covered on the surface by a thickened layer of cuticle, which at the end may be prolonged into a point. Such papillomata occur frequently upon the skin and tongue.

Others are composed of a series of minute outgrowths, subdivided at their tips (compound papilloma). Others again, in the bladder, form branched or dendritic masses, covered with columnar epithelium (villous growths); while those that occur in the ducts of the breast, and in ovarian and parovarian cysts, are more complex still, the interstices between the papillæ being prolonged downward as glandular tubules.

The external form and consistence necessarily vary very greatly, even in those springing from the same structure. For example, warts; fleshy, vascular verrucæ; and even long, spiral horns—composed of closely-packed cornified

papillæ—may appear upon the skin. The cause is usually some irritant, and, therefore, papillomata are often multiple, as in the case of warts on butchers' hands and of the verrucæ, which are associated with discharges from the generative organs. In some cases this is so striking that a local infection has been suggested as the cause, and various forms of bacilli and psorospermiæ have been described in connection with them.

### Adenomata.

Adenomata are hyperplasias of gland-tissue of which the epithelium presents the regular and orderly arrangement, reproduces the general form, and does not overstep the general limits of the gland in which they originate. Clinically, they are always innocent, but so closely do the so-called adeno-carcinomata resemble them histologically that it is rather by their general characters and limits than by their microscopic structure that they may be distinguished in some instances; for example, the true adenomata of the intestine never pass beyond the mucosa, while the cancers extend through it, penetrate the muscular coat, and even involve adjacent organs. Adenomata are described as tubular, acinous, and follicular, according to the type of gland-tissue. They occur in the breast, intestine, cutaneous glands, ovary, thyroid, parotid, liver, and kidney.

*Physical Characters.*—In the breast and skin they are nodulated, encapsuled, and freely movable; in the uterus and intestine they form polypoid outgrowths; in other organs, as in the ovary, they may involve the entire structure. Cysts are frequently present, being formed either from gland-tubules or from closed follicles, as in the ovary and thyroid.

Microscopically, the simplest form is the common mucous polypus of the rectum, which is composed of tortuous branching tubules lined with a single layer of columnar epithelium, and whose archetype is the Lieberkühn's crypt. The stroma is soft, œdematous, and made up of a fibrillar tissue with stellate and round cells. The common statement that adenomata do not secrete is erroneous, for the tubules of rectal polypi pour out quantities of mucus, and many "goblet cells" may always be observed; and in a specimen of fibro-adenoma of the breast, removed soon after lactation, I found a quantity of milk which exuded from the section. In fibro-adenoma of the breast the gland-tissue takes the form of elongated, curved, narrow *cul-de-sacs*, probably elongated acini, or of ducts cut across or terminating in trefoil-shaped alveoli. The new formation of gland-tissue is often inconsiderable, and it would appear as if that of a mammary lobule were merely stretched out and deformed by a growth of connective tissue.

Cutaneous adenomata are of two kinds—the sudoriparous and sebaceous. The former are composed of tortuous columns of small, spherical epithelium, the latter of gland-tissue of an acinous type, the acini being filled with fatty matter and epithelial cells. Both form freely movable, firm tumors, having a lobulated structure, and they are prone to undergo calcerous degeneration. The sebaceous adenomata are usually situated on the scalp.

### Carcinoma.

Carcinomata are overgrowths of the epithelial linings and glands of the body, which spread indefinitely by infiltration through contiguous structures, and are prone to affect early the lymphatic glands by transference of their elements along the lymph channels. Those originating in glands offer an irregular, disordered, and rudimentary resemblance to the mother gland; sometimes it is closer, but the likeness is never so exact as in the adenomata, the arrangement of the cells being less regular, with no attempt at the formation of a basement membrane. Some of the clinical differences have already been alluded to.

Cancers are divided anatomically into groups, in accordance with the nature of their epithelium.

*Squamous epithelioma*, for example, springs from the stratified epithelium of

the skin and mucous membrane; *cylindrical-celled*, from the columnar epithelium of the mucous tracts and glands, and *spheroidal-celled*, from that which lines secreting structures in the breast, kidney, testicle, etc.

*Squamous-celled Epitheliomata.*—These form flattened, superficial, or more

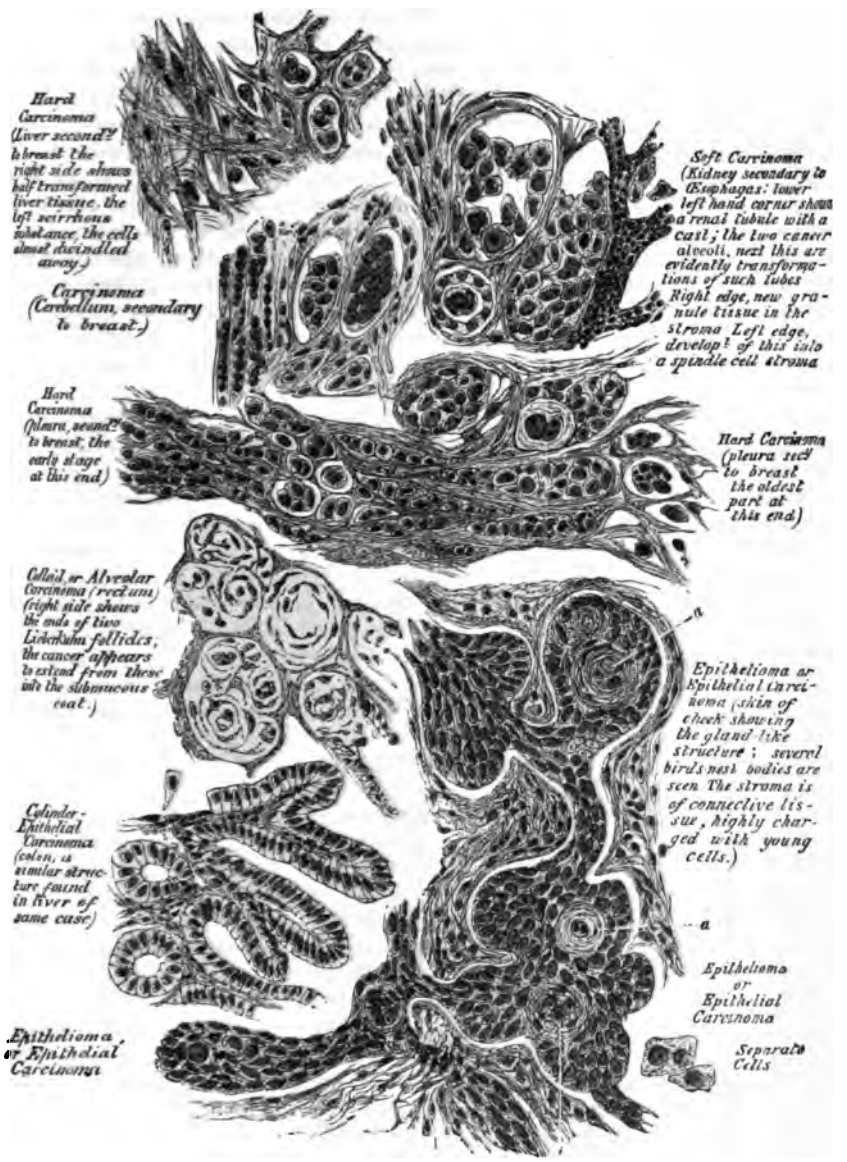

Hard Carcinoma (Liver secondary to breast the right side shows half transformed liver tissue, the left scirrhous tubal cancer, the cells almost dwindled away.)
Carcinoma (Cerebellum, secondary to breast.)
Soft Carcinoma (Kidney secondary to Œsophagus: lower left hand corner shows a renal tubule with a cast; the two cancer alveoli, next this are evidently transformations of such tubes Right edge, new granule tissue in the stroma Left edge, develop! of this into a spindle cell stroma
Hard Carcinoma (pleura, secondary to breast; the early stage at this end)
Hard Carcinoma (pleura secd to breast the oldest part at this end)
Colloid or Alveolar Carcinoma (rectum) (right side shows the ends of two Lieberkühn follicles, the cancer appears to extend from these into the submucous coat.)
Epithelioma or Epithelial Carcinoma (skin of cheek showing the gland like structure; several bird's nest bodies are seen. The stroma is of connective tissue, highly charged with young cells.)
Cylinder-Epithelial Carcinoma (colon, a similar structure found in liver of same case)
a
Epithelioma or Epithelial Carcinoma
Epithelioma or Epithelial Carcinoma
Separate Cells

FIG. 20.—Carcinoma. (*a*) Cell-nests.

deeply infiltrating growths on surfaces lined by squamous or transitional epithelium. They often spring from a crack or papilloma, an old ulcer, a scar, or a patch of epithelium thickened by long-standing inflammation.

The superficial outgrowth or hypertrophy of epithelium constituting a wart or papilloma is sometimes followed by an ingrowth of the deeper layers, as, for

example, in chimney-sweep's cancer. However arising, the earliest change is an elongation of the inter-papillary processes of epithelium, and an infiltration of the corium or mucosa with leucocytes. The processes continue to grow downward as tap or finger-like prolongations, and soon are studded with cell-nests; finally, the normal boundary between the epithelium and sub-epithelial connective tissue is broken down, and the growing cells are merged in the subjacent connective tissue, which is infiltrated with leucocytes. The epithelioma may then be said to be definitely formed. The growth now extends in the direction of least resistance—namely, along the connective-tissue interspaces—and nuclei are carried with the lymph-stream into the lymphatics. A general infiltration or injection of the connective-tissue interspaces and lymphatics results, composed of tortuous columns and rounded masses of epithelium. In epitheliomata of the tongue, skin, and some other parts, the central cells of the tap-like prolongations from the surface and of the deeper masses become cornified, so that a transverse section shows a number of concentric laminæ bounded by a layer of epithelium, like the rete mucosum. These are the epidermic globes, cell-nests, or birds'-nests. But other smaller concentric whorls are interspersed irregularly throughout the growth, and perhaps may more strictly he termed cell-nests; they are much smaller than the epidermic globes, and are composed of a few plump, central cells, undergoing proliferation, surrounded by two or three layers of small, flattened cells (Fig. 20).

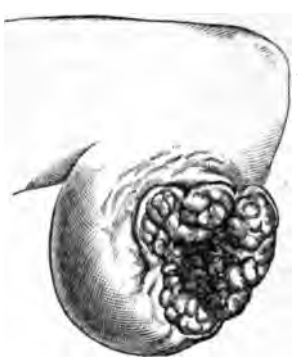


FIG. 21.—Epithelioma of stump, of two years' standing, from a man, æt. 58.

Ulceration usually occurs through breaking down of the superficial portions of the neoplasm. The surface of the ulcer, whether it fungates or is excavated, is surrounded by a raised, hardened, often sinuous edge, and its base is indurated in proportion to the depth of the infiltration. At times the surface is papillary, or is covered with thickened epithelium, as in growths on the heel; and even an extensive epithelioma of the tongue may present no ulceration. The lymphatic glands are involved very early in the disease, and if left alone its duration may be only a matter of months. Death supervenes from exhaustion, consequent on the local effects of the disease, and from cachexia, resulting from secondary growths in internal organs.

The chief seats of epithelioma are the junctions of skin and mucous membrane—as the lower lip, anus, and vaginal orifice; parts especially exposed to irritation, as the tongue; various parts of the skin, the glans penis, the palate, posterior wall of larynx, vocal cords, œsophagus, cervix uteri, and urinary bladder. In the latter organ it often produces soft papillary or vegetative outgrowths.

*Rodent Ulcer, Rodent Epithelioma, Cancroid of the Skin.*—These names are given to an exceedingly chronic, slowly-growing form of epithelioma affecting the upper part of the face of people advanced in years. Its favorite sites are the external canthus, the side of the nose, and temple. The disease first appears as a slight thickening of the skin, which spreads as a flattened, slightly-raised, superficial nodule, of which the centre becomes abraded. An ulcer results, having a smooth, dry, pinkish-red surface, which spreads, with a slightly-raised, rounded, firm border. Exceptionally, the centre of the nodule remains smooth, pale, and cicatricial, while the growth continues to extend at its periphery.

Histologically, rodent epithelioma is made up of rounded or lobulated masses of very small, round, or slightly flattened cells, usually invading only the corium. Cell-nests with cornification are absent, except occasionally in the thickened superficial epithelium covering the edges. In sections of growths before ulceration has taken place, the epidermis sometimes forms an unbroken layer, and has no connection with the underlying characteristic neoplasm. The sebaceous glands in the neighborhood are enlarged, undergoing transformation into the small-celled

growth, in which the sheaths of the hair follicles are also involved. There can, therefore, be no question that this peculiar neoplasm springs from the sebaceous glands and hair sheaths, and not from the epithelium of the surface. It is placed above the convolutions of the sudoriparous glands. The disease may exist for years, producing by its extent great disfigurement, and even destroying the bones of the skull and face, but it never implicates the glands. There is a great tendency to local recurrence after removal.

*Cylindrical-celled cancer, or epithelioma,* is the common form of morbid growth met with in the alimentary canal, from the cardiac orifice of the stomach to an inch above the anus; below this point squamous-celled epithelioma occurs. It is also observed in the mucous membrane of the body of the uterus and in the bronchial tubes. In minute structure these neoplasms form a more or less close reproduction of gland-tissue after the type of the tubular mucous gland. They are made up of a number of cylinders and alveoli lined with cylindrical epithelium, and result from a growth downward of the mucous glands into the mucosa. This becomes in consequence greatly thickened and upraised; subsequently the growth extends through the muscular coat, which on section appears much increased in breadth. So close a likeness in many cases does the new formation bear to gland-tissue that cylindrical-celled cancer is classed by Continental pathologists of high repute among the adenomata, notwithstanding its malignancy. But in some tumors, not otherwise differing in type, the cells retain the young spheroidal form, and are distributed in solid columns or rounded masses, instead of forming a lining to the alveoli. The naked-eye characters offer a great variety in form and consistence. A large number are firm and cicatricial, and the disease either constitutes a distinct tumor, or in the intestine has the appearance of a limited cicatricial contraction. Some form soft medullary masses fungating into the intestine, whilst in others ulceration is the prominent feature, adjoining viscera—as the bladder in cases of cancer of the rectum—being often penetrated. Excepting rodent epithelioma, this variety of cancer perhaps exhibits the slowest progress. Secondary deposits are found in the mesenteric glands and in the liver, to which cancerous emboli are carried by the portal veins. The seats of predilection are the cardiac and pyloric orifices, the sigmoid flexure and rectum.

*Spheroidal-celled Cancer.*—This occurs in the breast, testicle, ovary, nose, and palate. The common cancer of the breast may be taken as an example. This takes the form either of a general infiltration of the gland, or of a nodule, the physical characters of which are detailed elsewhere. The earlier stages which I have studied in chronic mammary indurations do not differ essentially from those of epithelioma. The first step is the proliferation of the epithelium lining the ducts and acini. These become choked and the surrounding tissue thickly infiltrated with leucocytes. Next the epithelium breaks through the basement membrane and grows into the connective-tissue interspaces, where the bulk of the neoplasm is formed. As a rule, the true gland-tissue has already undergone atrophy. A reactive new-formation of connective tissue follows the inroads of the epithelium. If dense fibrous tissue is formed in abundance, the tumor is hard and scirrhous; if the connective tissue is soft and small in quantity, it is medullary. Between these extremes every grade may be observed. The amount and distribution of the epithelium offer corresponding variations. In scirrhus it is scanty, the cells are small and arranged in elongated groups (alveoli), between the broad fibrous bundles. In softer tumors the cells are large, often coalescent, and arranged in long chains and columns, or in large rounded masses. Rare examples are met with in which a closer likeness to gland-tissue exists, owing to the arrangement of the cells in the form of a lining to the alveoli.

The clinical terms, hard or scirrhous, soft or medullary, have lost their pathological significance; the difference depends on the relative amount of the stroma and epithelium respectively.

Cancers undergo fatty, mucoid, and colloid metamorphosis. The fatty change is common in cancers of the breast, and in squamous-celled epitheliomata,

from a section of which worm-like masses of fatty epithelium may be expressed. Colloid metamorphosis (colloid carcinoma) occurs in growths of the stomach, intestines, ovary, thyroid, and rarely in the breast. In this change drops of colloid material appear in the protoplasm of the epithelium, pressing the nucleus to one side and distending the cell in the form of a vesicle. The cell wall gives way and the cells merge together in a gelatinous mass. In the alimentary canal these often constitute exuberant outgrowths, which on section exhibit to the naked eye large alveoli bounded by thin bands of stroma and containing soft, white jelly-like material.

Cancers of the breast more commonly undergo mucoid metamorphosis, which attacks the stroma. The epithelium is unaltered, and the alveoli are bounded by broad, transparent, hyaline bands of connective tissue. A section presents a uniform, moderately firm, gelatinous aspect. Such growths are described as carcinoma myxomatodes.

The chief characteristics, common to all cancers, are as follows: they form infiltrations which spread indefinitely without any sign of boundary or capsule. On section a reticulated or alveolar appearance may usually be distinguished with the naked eye. Their alveolar structure is marked under the microscope, a condition not met with in any other form of malignant tumor except the alveolar and melanotic sarcomata. A scraping of the surface yields a milky juice. This cannot be obtained from soft sarcomata until they have been kept about twenty-four hours. Cancerous ulcers resulting from growths in the skin are usually crateriform with infiltrated edges.

The elements of the disease are carried directly along lymphatic channels to the corresponding group of glands, from which general dissemination by the blood takes place. Among organs commonly the seat of secondary formation are the liver, lungs, heart, adrenals, kidneys, spleen, and the bones. The disease also spreads by contiguity in neighboring parts and by transference along the lymphatics; thus, in a case of contracting scirrhus adherent to the skin—in which there were one or two nodules—an injection of Berlin blue permeated the alveoli of the primary growth and passed into the minute lymphatics of the skin, demonstrating the direct communication of the former with the lymphatic system. The blood-vessels of cancer ramify in the stroma, and capillaries never penetrate between the cells, as in sarcoma.

The largest number of cases occur between the ages of 41 and 50; after that they gradually diminish. A considerable proportion are met with earlier in life but only 4 per cent. before the age of 20.

Sarcoma is a disease of an earlier period, and originates for the most part

# PART II.

# GENERAL PATHOLOGY OF INJURIES.

## CHAPTER I.

### *THE GENERAL EFFECTS OF INJURY.*

### SHOCK.

Shock is the effect produced upon the nervous system by violent stimulation of peripheral nerves or by mental emotions.

**Causes.**—These are exciting and predisposing, but the latter are in many instances so important that the distinction between them can hardly be maintained.

The immediate cause is usually the excessive stimulation of a number of sensory nerves, as in extensive burns or when a limb is crushed; but the seat of injury, the mode of infliction, the surrounding conditions, the age, sex, and temperament of the patient, and particularly the amount of blood lost, are of very great importance.

Injuries of the abdomen, urethra, and testis are especially liable to be followed by shock. The effect of a blow upon the epigastrium, of the passage of a catheter, and of violent squeezing of the testis, is well known; the most typical examples are produced in this way, and sometimes they are so severe as to prove fatal.

Concussion of the brain may be regarded as a form of shock, modified by the predominance of certain special and local effects. Division of the cord in castration; section of the bone in amputations; blows upon the cardiac region; and, still more, injuries to the heart itself, are not uncommonly followed by very severe shock.

Loss of blood, if sudden, may of itself cause the most intense shock, and in all cases is a very grave addition. Exposure to cold during operations renders a patient especially liable to it, particularly when ether is used. Mental emotion is of the highest importance; of itself it is sufficient to produce a fatal result, and in all cases it is a very powerful element. In railway accidents, for example, and in earthquakes, shock is especially severe; it may cause death without any discoverable lesion, and not only immediately from intense emotion, but later, after some days or weeks, from gradual failure of power. The nervous system is so profoundly affected that it is unable to recover itself; one single stimulus has left upon it an overpowering impression.

Those who are worried and anxious suffer more severely than others, and nothing is more disastrous than the conviction that an operation will be fatal. On the other hand, in great excitement or intense mental preoccupation, not only shock, but even pain is not felt, at least for the time. Afterward, owing to exhaustion, reaction is usually more acute.

In children the element of mental emotion is much less prominent, and unless there has been great hemorrhage or prolonged exposure to cold (both of

which they stand very badly), they suffer much less than adults. Probably, too, this is one of the reasons why the shock in amputation for disease is so much less than it is in a primary operation. Old people are usually affected very slightly, but when it does occur in them it is very grave.

No pathological lesion has ever been found; even the condition of the heart is not constant, although it is usually flaccid and relaxed. The change is essentially a molecular one; the energy of the active tissues, especially the nerves and muscles, suffers the most extreme depression; they are incapable of putting out any force, or of producing the amount of heat requisite to maintain the temperature of the body; the power of doing work of any kind is lost.

Those are most liable to suffer from it whose nervous system is already in what must be called, for want of a better term, a state of depression, whether this is due to natural temperament, or to cold, exposure, fatigue, violent emotion, loss of blood, or other accidental conditions.

**Symptoms.**—Two varieties of shock are described, the one characterized by extreme depression, the other, which is much the more rare, by great excitement. Upon what the difference depends, why one form should occur and not the other, is not known.

In the ordinary form the patient lies perfectly quiet with the eyelids half-closed and the limbs in the position that chance may have placed them; conscious, but paying no attention to anything around; able to speak feebly and slowly, but entirely incapable of any mental effort. The face has lost all expression; the skin is cold, pale, and clammy, that on the forehead often being covered with perspiration; the pulse is frequent, generally more or less irregular; the artery seems to collapse and empty itself between each beat; the respiration is shallow, and the temperature far below normal—sometimes as much as three or four degrees. The sphincter ani is usually relaxed; urine, if the bladder is full at the time of the accident, is retained; but afterward, for many hours, the secretion stops almost altogether.

In the worst cases, such as are almost certain to prove fatal, there is complete absense of the sense of pain. I have many times seen patients dreamily looking on, without a sign of intelligence, while broken fragments of bone were being removed and search made for bleeding arteries, in limbs that had been crushed in a railway accident.

Vomiting is of frequent occurrence; in head injuries it not uncommonly marks the onset of reaction, and in a few moments the face becomes flushed and the pulse regains its vigor and fullness. In other cases it may either occur at the commencement, when it is of comparatively little significance, or later, after a few hours, and then it not uncommonly marks the beginning of the end.

Shock may be almost instantaneously fatal; I have known death to occur within five minutes from puncturing a small hydatid cyst in the liver; or it may begin more gradually and slowly become worse and worse until death ends the scene.

The other variety, that which is characterized by furious excitement, is more uncommon. Its onset is nearly always gradual; at the first there is some ground for hope, and the general condition appears not altogether unsatisfactory, although the pulse is very rapid and devoid of power; very soon, however, the patient becomes restless and begins to talk volubly and incoherently; delirium sets in; the limbs are thrown wildly about, utterly regardless of pain; and in a short time this is followed by a condition resembling furious mania. The result is invariably fatal, from collapse.

**Diagnosis.**—Syncope due to failure of the blood-supply of the brain rarely causes any difficulty; with hemorrhage, especially when it is internal, it is different. In many cases of injury to the abdominal viscera it is practically impossible to make a diagnosis, the two are so often associated. Given a case of severe contusion followed by collapse, it may be due to shock alone or to shock complicated by hemorrhage from rupture of the viscera or tearing of a mesenteric artery or

vein, and there is no certain method of separating one condition from the other. Failure of sight due to anæmia of the retina, constant yawning or deep sighing inspirations, and throwing the arms about over the head, are very suggestive of hemorrhage, but nothing more; and a great deal of blood may collect in the abdominal cavity without causing any marked degree of dullness.

**Prognosis.**—The condition of the pulse and the temperature together give the best clue (always provided there is no hemorrhage), but a great deal depends upon the kind of injury. Shock may prove fatal almost instantaneously, or it may be very severe at first and gradually pass off; or, especially after extensive injuries, it may steadily grow worse and worse, until at length the pulse fails completely. The maniacal form is nearly always fatal.

Whether an operation should ever be performed during the continuance of shock is a question that depends upon the injury. So far as primary amputations are concerned, I am sure that the best course to follow is to stop the hemorrhage, prevent decomposition by wrapping up the limb in a strong solution of corrosive sublimate (1 part in 500), and leave it, not until reaction is beginning, but until it has thoroughly set in—and this may not be for more than forty-eight hours. It is impossible at first to say whether the patient will live or not; when in this condition, an operation will almost certainly prove fatal. Even when reaction is commencing, the same result is highly probable. I have on more than one occasion seen a patient's face suddenly change and felt the skin grow cold again as the bone was being sawn through; while if the hemorrhage is stayed and decomposition prevented (as it can be in nearly every case), the patient at least can come to no harm.

The exception to this is where it is necessary to perform an operation, such as opening the abdomen, for the arrest of hemorrhage. This must, of course, be done at once.

Ether is the anæsthetic usually recommended for operations in these cases, but chloroform is as safe if given in very small quantities; a patient suffering from shock is already almost insensible to pain, and requires very little to produce complete anæsthesia.

**Treatment.**—Hemorrhage must, of course, be stopped at once; crushed limbs rarely bleed from the large vessels, but often there is a considerable amount of general oozing, which is serious in such a condition as this. Very hot water (with corrosive sublimate), and afterward firm bandaging, is the most satisfactory method. The elastic tourniquet should not be used, as it is liable to cause sloughing. Where a mass of muscle projects from the end of a crushed stump and persists in oozing, it may be ligatured and cut away.

Warmth is the first essential—hot blankets round the patient, and hot bottles outside these. Stimulants are usually required, but they must be given in very small quantities, at intervals of half an hour, and careful watch must be kept upon the condition of the pulse; as it improves the intervals can be lengthened. If there is much sickness, a larger amount may be injected into the rectum. Subcutaneous injections are sometimes resorted to when the patient is insensible and an immediate effect is desired. Ether, perhaps, acts more rapidly than brandy, but its effect is more evanescent. In many cases ammonia may be given with advantage, either with the brandy (liq. ammoniæ aromat., ʒj) or even, if the heart is certainly failing, hypodermically, by intravenous injection, as in cases of snake-bite.

Strychnia, digitalis, and other drugs from which much was expected, have all proved fallacious; a very small quantity of morphia (⅛ gr.), locally, is beneficial, relieving the pain and so diminishing one cause of the depression.

Transfusion with blood or with a saline solution is of very little use, if any, in shock uncomplicated with hemorrhage. Possibly a certain amount of benefit may be derived from raising the limbs, surrounding them with cotton-wool, and then bandaging them, so as to diminish as far as possible the area over which the blood in the body has to be distributed.

## DELIRIUM TREMENS.

Delirium of various kinds is met with after injuries. Sometimes it is due to the anæsthetic, or to prolonged exhaustion and exposure, just as occasionally it occurs during the convalescence from protracted fevers; in other cases fat-embolism or the absorption of some poison from the surface of a wound may be the cause, but the best defined and the most characteristic is that which is the result wholly, or in great measure, of alcoholism.

Delirium tremens may occur without injury of any kind, but, as met with in surgical wards, it usually follows an accident, often one of a very trivial character, two or three days after it has been inflicted. Sometimes it can be traced to a prolonged debauch, but it is more frequent in those who, like many brewers' draymen, if they are never wholly sober, are never positively drunk.

The first night is passed in comparative peace, although the patient may not sleep. Next morning the tongue is white, flabby, marked by the teeth, and exceedingly tremulous; the face is flushed and anxious, the hands are strangely restless, the patient seems unable to control them or even direct their actions; every movement is attended with characteristic tremor; the appetite is lost; the skin is cool and often moist; the bowels are confined, and generally there is a tendency to nausea. Toward evening the symptoms grow worse; the pulse becomes very rapid, wanting in volume, and frequently dicrotic; hallucinations, often of the most disgusting character, make their appearance: the patient yields easily to control, but only for the moment: the same idea returns again and again—it may be the sight or the sound of something that fills him with apprehension, or it may be something utterly unintelligible, referring in an indistinct way to his occupation; at the same time there is the most ceaseless movement: the hands are never still, aimlessly turning the bedclothes over and over, in a curious, objectless, mechanical manner; the patient lies down, starts up, turns around, looks behind, beneath, above him, anywhere, and does anything but remain quiet for one single [illegible]. There is rarely any violence: almost always [illegible] be will be down; but it is utterly beyond [illegible] and all the while there is the most [illegible] something unknown, not to be described.

[illegible] with morning the symptoms subside in a [illegible] The [illegible] is greater, the pulse [illegible] and although the hallucinations are not so [illegible] and restlessness persist. The fore- [illegible] is nearly always abnormal; [illegible] in a way that is [illegible] the nervous system.

[illegible] well and the symptoms [illegible] already [illegible] a severe one, and sleep does [illegible] becomes more [illegible] being scarcely distinguishable [illegible] becomes shallow and [illegible] with persistence,

[illegible] must be very guarded;

[illegible] the state of the kidneys,

[illegible] a good night's [illegible] amount of food, [illegible] in these cases there is [illegible] at longer periods, [illegible] aromatics if diarrhœa [illegible] with ergot, bromide of is

even better, if the patient can be induced to swallow it; but often he will take nothing at all, or only such things as, from their extreme pungency or acidity, will stimulate a corrupted appetite.

Bromide of potash is sometimes given in very large doses, but without much avail; chloral is decidedly dangerous, as it tends to increase the vascular depression; opium, or, better, morphia injected hypodermically, deserves more reliance. One-third of a grain given in the afternoon, before the symptoms attain their full severity, and followed by a second similar dose in the evening, is often effectual; but care must first be taken to examine some of the urine. If the opiate does not succeed, and the sleeplessness still persists, the head may be shaved, and cold water (half-a-dozen jugfuls) poured over it; or chloroform may be cautiously tried, the patient being kept under its influence for twenty minutes or half an hour. If these measures fail, if the patient will not eat and cannot sleep, and particularly if from the condition of his kidneys it is not advisable to administer opium, there is no alternative but to give stimulants. If the pulse is a running one, and they are not given, the patient will almost certainly die. In the vast majority of cases there is no doubt it is better to cut them off at once (though it is quite possible it makes the patient worse for the time), but I have seen many instances in which I am sure the free use of stimulants saved life. The best is bottled stout, of the heaviest and sleepiest description, and it should be given freely, without stint, until either the pulse changes its character or the patient falls asleep.

The bowels should be opened as soon as possible; the liver is almost always congested, and it may become necessary to administer nutrient enemata. Quinine and bitter tonics, or alkalies, with carbonate of ammonia, may be advisable for the gastritis and to improve the appetite; tincture of capsicum is said to be of especial use; but large doses of digitalis are too dangerous.

[The use of beef tea is usually followed after a time by great relief, and where there is extreme weakness it may be combined with brandy or sherry. Of such a mixture the dose will vary from a few drops every ten or fifteen minutes to a teacupful every two hours.]

In many surgical cases restraint of some kind is absolutely necessary, but wherever it is possible, anything of the nature of a strait-waistcoat should be avoided. Of itself it is sufficient to induce delirium and a severe degree of fever. Patients who are suffering from delirium tremens are for the most part very easily controlled, so long as the attendant is firm; and it is only in cases of extreme violence, or when there is a fracture which it is absolutely essential to keep quiet, that any tight restraining appliance is advisable.

## TRAUMATIC DELIRIUM.

Traumatic delirium, in the strict sense of that term—excluding, that is to say, the delirium due to pyrexia, that which occasionally follows an anæsthetic, delirium tremens, and those forms which are caused by the absorption of poisonous alkaloids—is decidedly rare. Sometimes, however, a kind of delirium attributable to nothing else is met with, especially in old people; although, as it is more usual after fractures, it is possible that the symptoms are due, in a measure, to fat-embolism.

The delirium is not like that of delirium tremens; it has not the same restless, busy character, and the hallucinations are not of the same disgusting description. The patient is often exceedingly supicious, imagining that every one is wishing to injure him; but when left to himself he remains quiet, watching everything perhaps, and his movements are not tremulous. The tongue is often furred and white, but it can be protruded without fibrillar contractions; food is taken readily; and though the patient's sleep may be disturbed, there is not the same distressing insomnia. Usually the symptoms subside of themselves in the course of a day or two, with a moderate supply of stimulants; but it sometimes happens that they persist, and the mental disturbance is permanent.

## TRAUMATIC FEVER.

Every kind of fever that follows injuries has been described under this name; strictly, it should be limited to that which results from them directly, and should be clearly separated from those which are due to septic decomposition and other secondary changes. Two varieties may be distinguished—the one caused by nervous irritation; the other by the absorption of certain substances from the interior of the wound.

(A) The neurotic form sets in almost at once, reaches its maximum within the first five or six hours, and then begins to subside again. Irritation of peripheral nerves, pain, mental emotion, and perhaps other causes appear to possess the power of increasing the production of heat, possibly by inhibiting the controlling influence of the heat-centre. In excitable children, and occasionally in women, the mere sight of the preparations for dressing a wound, the knowledge that the time for it has come, or even the apprehension of an operation, is sufficient to raise the temperature as much as two degrees. The same causes, acting with greater intensity, or under different circumstances, give rise to shock, a condition of general depression affecting the whole of the central nervous system.

(B) The other variety, that which is caused by the absorption of certain substances from the interior of the wound, sets in more slowly, and continues so long as there is anything to be absorbed. It is probably due to some of the products that are set free during the coagulation of the blood, as it has been shown that the injection of fibrin ferment can excite pyrexia, and that the height to which the temperature rises is to a certain extent dependent upon the amount of the extravasation. At the same time, other substances set free from crushed and bruised tissues may have some influence; and the tension which is always present in the case of large extravasations may help, partly by its effect upon the nerves, partly by the way in which it assists absorption. As a rule, the fever subsides in the course of forty-eight hours, but it may last a week or more; the temperature, which is of a remittent character, steadily falling after the first day.

## CHAPTER II.

### *LOCAL EFFECTS OF INJURY.*

Injuries are divided into two classes, subcutaneous and open, as the latter are liable to complications from which the former are practically exempt.

### 1. SUBCUTANEOUS INJURIES.

Simple contusions only are dealt with here; injuries of special structures are reserved for more minute description.

Contusions are caused by blows from some hard, blunt object, or by violent squeezes. Blood may be extravasated into the skin, but the surface is not broken; that constitutes an open wound at once. The soft parts beneath sustain the brunt of the violence; the connective tissue with its delicate vessels first; then the muscles, which may be crushed or torn; veins, lymphatics, and, to a less extent, owing to their elasticity, arteries come next; while nerves, as a rule, resist, however much they are stretched.

Contusions vary in degree from a trivial bruise to absolute crushing. Clinically, the number and size of the vessels torn are the most important features. In the slightest form—a wheal, for example, produced by the lash of a whip—there is no bruising perceptible, merely redness and swelling, with local pain, which soon subsides. If it is more severe, a certain degree of ecchymosis follows; some of the capillaries are ruptured; blood is effused into the skin or the subcutaneous tissue; and, according to the structure of the part and the violence of the injury, swelling and discoloration make their appearance. In the worst cases, in which a large vessel has given way, or in which the tissues are soft and easily torn, the amount of extravasation may be enormous; the skin may be separated from the deep fascia of the limb by a layer of fluid blood extending over an immense surface, and the case may prove fatal almost at once from hemorrhage alone.

A circumscribed swelling in the connective tissue is called a *hæmatoma;* usually it can be recognized at once by its soft fluid centre and its hard and firm margin. When the blood collects in some internal space it is known as a *hæmatocele. Cephalhæmatoma* occurs upon the head, either in the subaponeurotic or the subperiosteal layer of the scalp.

The blood pours out until the tension of the extravasation is equal to that at the orifice of the ruptured vessel, then coagulation sets in, and after a variable time the clot breaks down, forming a thick, turbid fluid, darker than blood, but still reddening when exposed to air.

The subsequent changes depend upon the amount of the extravasation, the tension, the nutrition of the tissues around, and the way in which the injured part is treated. *Absorption* is the rule; the red corpuscles and the fibrin break down, the hæmoglobin is set free and soaks into the loose cellular tissue, the fluid serum is carried off by the lymphatics, and, when the amount is only small, the white blood-corpuscles wander away. If the extravasation is a large one, the leucocytes in the centre, too far separated from the living tissues, share the fate of the red ones. Finally, the hæmoglobin is removed and all traces of the injury disappear.

In other cases, however, absorption is not so perfect; a certain degree of *organization* makes its appearance round the margin, lymph is poured out by the tissues near, and a layer of granulation-tissue, which may become fibrous or even bony, is developed around it. When this takes place, the coloring matter dis-

appears, the fluid in the centre grows paler and paler, and at length the blood-clot becomes converted into a cyst or, more frequently, a thickened, rigid layer of dense fibrous tissue without any central space. After a time this too disappears, probably undergoing fatty degeneration and absorption.

Finally, if the tension is high (as when a large artery gives way), or the part is not kept at rest, or the tissues round are so badly nourished that they are unable to stand even the slight irritation of the extravasated blood, inflammation sets in; and then, unless speedy steps are taken to prevent it, *suppuration* is very likely to follow, the pyogenic organisms finding their way to the injured part, either through the blood-vessels, or if blebs form upon the surface and the epidermis gives way, directly through the tissues.

No material suits them better than extravasated blood, especially if the tissues round are injured by tension or are not kept at rest. Hæmatomata in the wall of the thorax and between the muscles of the abdominal wall seem peculiarly liable to break down; the cephalhæmatoma of infancy never does.

### Signs of Contusions.

The degree of swelling naturally varies with the amount and situation of the extravasation and the looseness of the tissues. Pain, unless a nerve-trunk is struck, chiefly depends upon the tension. In some instances—when, for example, the testis is squeezed or the abdomen struck—the shock is very severe. If a large vessel is torn, the loss of blood may prove fatal at once, and even if it falls short of this, the hemorrhage is often exceedingly serious. The staining, if the bruise is superficial, soon shows itself; when it is deep it may not appear for weeks, and then in some far-distant part; rupture of one of the deep veins of the calf, for example, causes discoloration behind the internal malleolus, and in the palm of the hand leads to peculiar purple crescents at the angles between the fingers. The color varies in the same way; under the conjunctiva it is a bright red; in the loose tissues of the eyelids, black; where the skin is thicker, it is blue or green, and when the extravasation is very deep it is lemon-yellow. As the stain dies out it passes through the same changes [giving in succession the colors of the blood-spectrum.]

Traumatic fever is very general, and, in the case of large extravasations, not unfrequently severe for several days.

If the bruise is superficial, the skin over it becomes hot and red, owing to the increased vascularity of all the tissues round; more blood flows through the vessels, because there is more work to be done and a greater amount of repair is required. Provided the part is kept at rest, this soon subsides; but if the tension is not relieved, or if any fresh injury is inflicted, inflammation sets in, the swelling continues to increase, the pain becomes more severe, the skin becomes shiny, perhaps œdematous, and then there is every prospect of suppuration.

**Treatment.**—Slight contusions are best treated with cold or evaporating lotions; lead lotion is especially useful if there is any redness of the skin. Arnica should not be employed at all; its merit is due to the spirit the tincture contains, and it often causes an eruption. Where the extravasation is considerable, uniform, gentle compression, with many layers of cotton-wool, checks the increase, limits the hyperæmia, and promotes absorption better than anything else. Even when the epidermis is lifted up and bullæ are forming upon the skin, nothing answers better. The fluid should be drawn off through a minute puncture and absorbed with cotton-wool or thick blotting-paper, the epidermis carefully replaced, a little iodoform dusted on, or collodion painted over, and then cotton-wool carefully applied.

In very severe cases, where there is risk of suppuration, aspiration often averts the danger; there is no need to empty the cavity; removing a small portion of the fluid relieves the tension; the hyperæmia begins to diminish at once, the skin loses its shiny, glazed appearance, and absorption proceeds unchecked. Of course,

if a large artery has given way in one of the limbs, so that the collateral circulation is interrupted and the part below is cold and œdematous, other measures are required.

Occasionally it happens that the contusion of the skin has been so severe as to kill it; if the extent is only small and the deeper structures are not badly injured, the slough should be allowed to separate of itself, and the resulting wound will soon close; but where, as in railway and tram-car accidents, the skin has been stripped off from the subcutaneous tissue for some distance above the apparent seat of injury, and it is thought advisable to amputate, the line of incision must be carried well above, or the flaps are sure to slough.

## 2. OPEN WOUNDS.

Injuries in which the skin (or the mucous membrane) has given way, so that the deeper structures are exposed to the air.

Wounds are described as *incised*, when inflicted with a sharp, clean-cutting instrument; *lacerated* when the parts are torn; *contused* when they are bruised; and *punctured* when caused by the thrust of a pointed weapon. *Poisoned* wounds, in which there is more than the simple division of the tissues, must be treated by themselves.

*Incised Wounds.*—In these the injury is limited; on either side there is only a thin layer of tissue the vitality of which has been destroyed. The symptoms are *pain*, from division of the nerves and exposure of the divided ends to the air; *bleeding*, from the vessels that are cut, varying in proportion to their size and importance; and *gaping*, owing to the elasticity of the tissues. Skin retracts more than anything else, especially when the wound is transverse (except in such situations as the palm of the hand, where it is bound down much too tightly): arteries, if they are simply wounded, bleed most persistently, as the wound is held widely open; if they are completely divided, they shrink together and retract, so that their ends can hardly be seen, and the amount of bleeding, except in the case of the larger ones, is comparatively inconsiderable; veins retract less, but unless they are varicose, and hemorrhage is favored by position, bleeding is seldom serious from them. Muscles, when cut across, shorten at once, and often continue to shrink for some time. Fibrous tissues and nerves, on the other hand, retract but little; there is no tension upon them.

*Contused and Lacerated Wounds.*—The skin and the soft tissues are torn and crushed and, especially in the former, the injured area is often very much larger than it appears to be. The degree of gaping naturally depends upon the size, depth, and direction of the hurt; the pain is usually of a dull, aching character, not so severe as in the incised kind; and the hemorrhage is less extensive. Capillary oozing may be present to a considerable degree, but large arteries rarely bleed in contused and lacerated wounds. The inner and middle coats break off at a different level to the outer one, and they curl up together inside the sheath, so that sometimes not even a drop escapes. An arm may be torn off at the shoulder-joint without any loss of blood from the axillary. The fear is that, owing to the amount of dead and dying tissue, decomposition may set in and open up the way for the whole series of septic processes.

*Punctured Wounds.*—These are caused by stabs with sharp-pointed instruments, such as bayonets and rapiers. The chief dangers are the very serious and concealed injuries that may be sustained by deep-lying structures, such as important vessels and viscera, and the fact that such wounds are nearly always valvular, so that proper drainage is impossible. Punctured wounds, as a rule, either heal at once, or lead to prolonged, deep-seated, and dangerous suppuration.

## Repair of Wounds.

Wounds in all cases are repaired by the formation of lymph, which first becomes vascular and then develops into a kind of fibrous tissue. Subsequently, where special structures are concerned, such as bone or muscle, further development may take place. If the amount of exudation poured out is very small, the wound is described as healing by the *first intention*; if there is a considerable quantity, as when a cavity has to be filled up, union is said to take place by the *second intention*. Immediate union, which has been described in the tongues of animals after incised wounds, is merely a variety of the former, characterized by possessing the minimum of lymph; union by the third intention and healing under a scab are only modifications of the latter.

The changes that occur after the infliction of a simple uncomplicated wound do not differ in the least from those that follow a sprain or contusion, or any other form of subcutaneous injury. The hemorrhage ceases, partly from pressure, partly from the coagulation of the blood and contraction of the torn and bruised capillaries; all the blood-vessels round the injured area dilate, more blood flows through the part (so that the edges of the wound, if it is on the skin, become swollen and slightly reddened), more plasma pours out through their walls, and the cut surface on either side becomes infiltrated with leucocytes and coagulating fibrin. At first, shortly after its infliction, all the separate structures can be distinctly recognized in the wound; in an hour or two they become blurred, the interstices between them and the surface over them are filled with the exudation, or, as it used to be described, the wound is glazed.

If the two surfaces are now brought into apposition, and no irritant of any kind is allowed to injure them, they cohere and become glued so closely to each other that even after twenty-four hours it is almost impossible to detect the line. This is *union by the first intention*. The lymph that unites the surfaces becomes organized, fresh vessels form from the old ones on either side, fibroblasts gradually range themselves along them, the cells and fibres that have been killed by the accident, and the small quantity of extravasated blood still left in the wound, are absorbed and carried off by the leucocytes, and soon a very thin, delicate layer of vascular, newly-formed fibrous tissue is all that can be seen of the lymph that filled the wound.

Meanwhile, the surface becomes covered with epidermis by the budding of the living cells on either side, and if the injury is inspected twenty-four hours after it has been inflicted, a faint red and slightly swollen line is all that is left. As organization proceeds, even this becomes less distinct; many of the new vessels disappear, and gradually the color fades until it is as pale as the parts around. There is no inflammation after a single, simple injury such as this; the changes are identical with those that occur after a bruise, in which the extravasation has not been sufficiently great to cause any tension; there is no loss of tissue, except that which is killed in the original hurt, and the only changes that take place are the ordinary ones that are going on every day; the sole difference is in their rapidity and energy; there is a greater amount of wear and tear than usual, and the process of repair is carried on with greater energy.

When the injury is more severe than this—when, for example, a definite portion of tissue is destroyed or lost—the process is exactly the same, always provided that no fresh irritant appears upon the scene. Suppose, for example, a cavity is left by the excision of a tumor, the surfaces of the wound not admitting of absolutely accurate adjustment. As before, the blood pours out, coagulation takes place, hemorrhage ceases, and all the vessels round dilate. As before, lymph pours out through their walls, and the leucocytes pervade everything—the softened and swollen tissues on either side of the wound, the little fragments of dead material that are left clinging to them, and the extravasation of blood that fills the cavity. In this case, the amount of lymph thrown out is much greater, there is much more *debris* to be removed, and a greater amount of repair required; but gradually it is

all done, and as the vessels grow into the exudation from the dilated capillaries round, the whole wound is filled from all sides and from below with newly-formed vascular lymph, so called granulation-tissue. This is *union by the second intention*, and it only differs from union by the first intention in the amount of lymph thrown out. There is no inflammation or suppuration, and there is no loss of tissue other than that caused by the original injury.

The mere presence of extravasated blood (always provided there is no tension and that it does not undergo decomposition) does not prevent union by the first intention, although it delays it; there is a greater amount of dead material to be absorbed, and naturally the process is slower, exactly as it takes longer to repair the effect of an extensive contusion than that of a slight one. And the same may be said of tissue-debris: a certain amount of tissue is killed in every wound; this is removed slowly by the leucocytes, which literally eat their way into it; the larger it is the longer it takes, but so long as it does not cause tension or lead to decomposition, union by the first intention is the rule. The pedicle of an ovarian tumor, or a stump of omentum strangulated as tightly as possible and returned into the abdominal cavity, does not interfere with immediate recovery; the lymph poured out by the tissues round it is able to deal satisfactorily with it.

*Healing under a scab* is the same thing. Supposing the cavity, instead of being deeply buried, involved the surface, the blood that pours out from the injured vessels, and the lymph that transudes through their walls, coagulate and form upon the top, where they are exposed to the air, a coating which grows harder and drier the longer it lasts. Under this the lymph becomes vascular, as before, and if at any time the scab is removed, a smooth, pale, glazed surface is exposed, consisting of myriads of leucocytes, traversed by capillaries, and gradually becoming organized, the deeper ones into fibrous tissue, the superficial ones, where they are in contact with the already existing epidermis or epithelium, into flattened cells of the same character. If the scab is detached before the surface is sound all over, a peculiar transformation occurs: instead of remaining flat the topmost layer of the lymph is raised up in the course of an hour or two into myriads of little points, each consisting of a capillary loop, covered with a layer of leucocytes; in other words, it assumes the typical character of granulation-tissue; as soon as the restraining influence of the scab is removed, the newly-formed vessels, the walls of which are exceedingly delicate, yield to the influence of the blood pressure, and stretch rapidly upward in the direction of least resistance, raising up with them a little covering of leucocytes, so that the whole surface appears granular. When this occurs, the superficial layers generally melt away as pus; but this is not essential, and must be regarded as a complication due to the incidence of pyogenic organisms.

If two surfaces, granulating in this manner and perfectly clean, are brought together and held in accurate apposition, the granulations fuse, vessels pass from one to the other, and union soon becomes firm. This is sometimes known as *union by the third intention*; it is chiefly of service in plastic surgery, or after extensive scalp wounds, in which the ordinary treatment has failed.

## CICATRIZATION.

In a simple incised wound, the edges of which are brought together accurately, there is no difficulty in understanding the reproduction of the epithelial or epidermic stratum that covers in the surface; the cells of the rete malpighii proliferate and multiply rather more rapidly than before; while the old stratum corneum is thrown off by the increased exudation beneath, and is quickly reproduced from the growing cells below. The same thing occurs when the extent of surface lost is greater; but the perfection of reproduction becomes less and less the further the cells lie from the edge of the wound.

If there has been any loss of substance the cavity must first be filled up by the formation of vascular lymph. As soon as this has taken place, or while it is

taking place, organization begins; the deeper layers gradually become convert into cicatricial tissue, and draw the edges of the wound together (in the case of circular area, in which the contraction takes place from all sides toward the centr the importance of this in connection with the healing of wounds is easily calc lated): the superficial ones, on the other hand, are transformed into epitheliu under the influence of the already developed cells at the margin. Without t presence of already existing epithelial or epidermic cells this is impossible; fre epidermis never makes its appearance spontaneously at a distance from the edge

The method is the same whether the surface of the lymph is protected fro all injurious influences or is exposed freely to the air; but the process is mu more rapid in the former, and there is no waste. In the latter, owing to t incidence of the omnipresent pyogenic organisms, suppuration usually occur many of the superficial cells are killed and lost as pus; and it is not until t tissues gain the upper hand and are able to resist the attack that organizati begins to make way; then it advances equally from the margin, forming epitl lium, and from the sides and base, forming fibrous tissue. By degrees, as t base contracts and the sides skin over, the area over which the pyogenic ger have power is reduced more and more until they are completely shut out. If any time, before this has happened, some other irritant comes to their aid, heali stops; and if it is of any intensity, the whole surface of the wound may bre down again.

The appearance of a wound as it heals, under these conditions, is ve characteristic. If the centre, where repair is not yet complete, has been cover by a perfectly dry scab or by some clean non-adhesive dressing, and this is moved, a pale, smooth, glassy-looking surface is exposed; this is the lymph t has grown up to replace that which has been lost. At the margins it passes imp ceptibly into the cicatricial epithelium; the surface seems to become dry; it d not reflect the light so readily; then, a little further off, its color changes, coming rather more blue or purple; and finally, it is plainly and definitel layer of young epithelium, continuous with that of the skin around. As grows older it becomes thicker, and allows less of the color of the parts bene to show through.

If, on the other hand, instead of being protected and compressed, the cen of the wound is exposed to the air, and suppuration has occurred, the appearanc altogether different. The color is a bright, florid red; all the vessels are dilate and the surface is no longer smooth, but covered over with myriads of little poir each corresponding to a capillary loop, which has been stretched out in the dir tion of least resistance, and has raised up on itself a covering of leucocytes. this is a little thin pus, formed from the most superficial cells which have perish but only sufficient to make the surface moist. Round it, and now seen very c spicuously from the difference of its level and the smoothness and dryness of surface, is the thin bluish rim of young epithelium, developing exactly as befor

In the case of large granulating surfaces, although repair may advance rapi at first, after a time progress becomes more and more slow, until often it cea altogether, whether because further contraction is impossible, or because infective power of the epithelium is too feeble at the distance. In such cas which are exceedingly common after burns, an attempt may be made to exped matters by what is known as grafting.

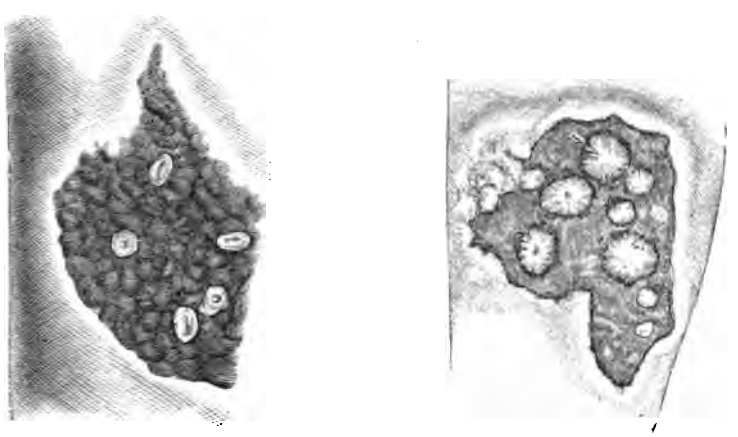
## SKIN-GRAFTING.

There are many ways in which this may be performed. The simplest epidermic grafting—consists in removing minute portions of the skin from so other part of the body by means either of special grafting scissors or a sharp scalp and placing them on the granulating surface a short distance from the edge. Ea of these grafts forms a new centre from which cicatrization spreads; and it m not infrequently be noticed, if one is placed near the margin when healing l

become slack, that the cells on the other side, those which are growing from the already existing epidermis, suddenly wake up into activity too.

It is not necessary or advisable to include the whole thickness of the skin; it is quite sufficient if the cells which still retain their power of growth are used. No real wound should be left; at the most, the spot from which the skin is taken should be reddened or marked with one or two dots of blood coming from papillæ, the apices of which have been taken off; and the size of the part that is used need be no larger than that of an ordinary pin's head. If possible, grafts should always be taken from the patient's own body, and from some part where the epidermis is not too thick; but if no objection is raised, the skin from an amputated limb may be made use of, or that which is removed in the operation for phimosis, especially as the vitality of the epidermis is greater in the case of children.

Grafting is of no use unless the wound itself is healing at the edges; sometimes when this is not the case—when the granulations are pale and œdematous—the grafts grow for a few days, but almost invariably they break down and disappear again; and they should always be placed with the natural surface downward, about three-quarters of an inch from the margin, on that part of the wound, in other words, which is in other respects ready for cicatrization. Great care should be



FIGS. 22 and 23.—Drawing Illustrating the Cicatrization of Sores by Skin-grafting.

taken not to make the surface bleed. The most satisfactory dressing is a single layer of gutta-percha tissue or oiled silk perforated with a number of minute openings, and covered with a considerable thickness of absorbent wood-wool. This may be left for a week or more, until the grafts are firmly set: the excess of discharge, which might otherwise wash them away or displace them, being absorbed through the perforations.

In the method advocated by Thiersch, actual portions of skin are used and the whole surface of the sore is covered over at once. It may be carried out in recent wounds, but it answers better in those which have been granulating for some little time, and in which the granulations are small and florid, a condition which usually follows the application of caustic or compression. The surface must first of all be thoroughly purified and washed with normal salt solution, compresses soaked in the same fluid being laid over the wound until the strips are ready. The most convenient situation from which to obtain the skin is the arm or thigh: the epidermis is first thoroughly scrubbed with a solution of corrosive sublimate or iodide of mercury in iodide of potash; then the antiseptic is washed away with salt solution, and long strips are cut off with a sharp razor as wide as the part will allow. The limb must be held firmly from beneath with one hand, so as to put the

skin upon the stretch, and a shaving as long as it is thought advisable quickly taken from the upper surface. The subcutaneous fat should not be included, but the whole thickness of the true skin is necessary (of course, it is thinner at the sides) so as to take in the layer that contains the horizontal plexus of vessels. If the plasma can enter into these through the cut ends of the vertical ones through which they are supplied, the nutrition of the graft can practically be assured. Strip after strip obtained in this way is placed upon the raw surface and pressed firmly into position until the whole is covered. A layer of protective, perforated with numerous large opening, is placed upon them, and over this compresses wet with salt solution, which are changed every day.

As a rule the strips unite at once; occasionally the granulations break through, and sometimes the edges are lifted up by the collection of the discharge beneath; even then the whole area rarely perishes.

[The method of Thiersch is now generally adopted in America. The razor is used by a sawing motion, and thin strips of skin are thus spread upon the outer surface of the blade.]

Frog's skin (*Annals of Surgery*, Feb., 1889) has been used in the same way. The same preparation and precautions are necessary, the skin of the back being carefully detached from the neck downward. The pigment-cells soon disappear; but apparently the skin itself lives, and forms a thin pellucid covering, through which the deep color of the vascular lymph beneath can be seen. After a time it becomes denser and more opaque, but it does not appear to possess the same power of resistance as human skin.

Wolfler has employed flaps of mucous membrane in the same way, obtaining them both from human beings after operation and from animals. Stricture of the urethra, for example, has been excised, and a graft of mucous membrane inserted in its place, with apparently good success; and defects have been remedied in the eyelids and elsewhere.

### Complications of Repair.

If the surface of the wound is irritated instead of being kept at rest, it becomes inflamed, and the inflammation continues so long as the irritant is at work. The process of destruction for the time the cause is acting is more vigorous than that of repair; healing is delayed, the loss of tissue is greater than that due to the original hurt, and the wound increases in size, sometimes merely the surface melting away (suppuration and ulceration); sometimes, when the irritant is more intense, the base and edges perishing *en masse* (sloughing and gangrene). Open wounds are naturally more exposed to the action of the irritants than closed ones; they are always liable to infection from the air and from contact with foreign bodies, and until recently inflammation was regarded as a necessary factor in their repair. It cannot, however, be too strongly insisted upon, that it is a complication, and an absolutely unnecessary one, caused by the action of some fresh irritant. It does occur occasionally in subcutaneous injuries as well as in open ones, but it should not occur in either. The sole difference, why it is so rare in the one and so common in the other, is that the former are protected from all external injurious agents by the skin, the latter are not. As soon as the irritant, whatever it may be, is removed, the inflammation ceases, and if the tissues have sufficient vitality left, the process of repair at once begins to make headway again.

1. *Simple inflammation.*—This is the product of mechanical or chemical irritants, not generated by organisms living in the wound.

Friction, want of rest, the tension of a tight suture, the presence of an irritating dressing (even when it is antiseptic), the accumulation of extravasated blood or wound secretion, inert foreign bodies, and many other irritants of a similar nature may cause it. Repair advances more slowly or is stopped altogether, the area of redness spreads, the swelling becomes more marked, the temperature of the part rises, the pain becomes more severe, and the patient feels feverish. The gravity of the attack depends upon the nature of the irritant and the condition of

nutrition. A tight suture will cause a rise of temperature of several degrees, and lead to a train of symptoms of altogether disproportionate severity. A bullet or a piece of silver wire, ivory pegs, or other similar inert substances, may remain embedded in the body for years, especially if they are fixed in some part that is not exposed to friction or movement. If they are near the skin or loose in the muscles, the irritation usually leads to the production of a capsule of cicatricial tissue, and not unfrequently, after remaining quiet for perhaps a number of years, suppuration suddenly sets in, the vitality of the tissues round becoming depressed by age or the addition of some slight injury.

If the cause is removed, the inflammation subsides and repair proceeds; if it continue, the vitality of the tissues is lowered, until at last they become too feeble to resist the assault of the pyogenic organisms, and suppuration follows.

2. *Septic Inflammation.*—Decomposition of the blood or lymph that fills the wound is a much more powerful cause. The micro-organisms of putrefaction are destroyed by living tissues; on the other hand, they grow and thrive in the fluid that exudes from them, especially when it is kept at the temperature of the body, causing either *septic fever* or *sapræmia*. If the wound is a recent one, and all the strata of loose cellular tissue round the bones and between the muscles are open and filled with extravasated blood, diffuse inflammation of the most terrible description is sure to follow, and very likely prove fatal from the intensity of the fever before there is time for suppuration. If, on the other hand, the tissues are better nourished, or the poison is not so active, and death does not ensue in the first two or three days from the sapræmia, suppuration sets in, the germs finding the soil that suits them best in the already half-killed tissues, and one or more of the varieties of suppurative inflammation follow.

3. *Suppuration.*—The pus of acute suppuration always contains certain organisms; it is believed, therefore, that it cannot occur without them, and that they are its cause. Ten or eleven different kinds are described as possessing this property, but only two, a staphylococcus and a streptococcus, are of common occurrence. They kill the leucocytes and transform them into pus-corpuscles; the tissues themselves, the walls of the vessels, and the plasma that pours out through them are destroyed, and converted by their peptonizing action into an albuminous fluid incapable of coagulation; and, so long as there is any tension or any other irritant to lower the vitality of the tissues round them, they spread their process of destruction far and wide. Over structures that are perfectly healthy they have no power. In children, therefore, and young and healthy adults, suppuration may be acute and severe, when there is tension or septic decomposition to help the germs, but it is limited; the nutrition of the tissues is too good for the micro-organisms to have any effect outside the immediate sphere of the other irritants; in those, on the other hand, whose constitutions are wreeked by disease or intemperance, resistance is enfeebled, and the suppuration is only too liable to spread.

That in the vast majority of instances these germs gain access through the wounds is absolutely certain; suppuration is of common occurrence in open injuries, while it is the exception in subcutaneous ones. As, however, it does happen occasionally in the latter, and as some of the worst and most fatal forms of suppurative disease occur without a wound at all, it is clear there must be other modes of entrance, too. Sometimes their presence may be accounted for by the existence of cutaneous lesions in other parts of the body; but, in all probability, as they abound in the alimentary and respiratory passages, they enter through the mucous membrane and are distributed by the blood. It is only, however, when they meet with tissues that have been already injured in some other way—by cuts or bruises, tension, septic poisons, etc.—that they are able to cause coagulation-necrosis and suppuration.

A certain amount of pus, generally very thick and viscid in character, is occasionally found when the dressings are removed from a wound, forming a thin layer over some part which the skin has failed to cover. It causes no rise of tem-

perature or fever, and the lymph beneath heals over rapidly as soon as the dressings are changed. Possibly, in many cases, it is not true pus (not the product of pyogenic microbes), but merely lymph which has perished, owing to its distance from its base of nutrition and its contact with a foreign body. In other cases, however, micrococci are present, having reached the part through the dressings or in some other way, and then the only explanation is that, owing to the thorough vitality of the lymph around and the absence of all other sources of irritation, they have been unable to effect more than the minimum of mischief. Suppuration of this description requires no special treatment; its existence is usually unknown until the dressings are changed.

Acute suppuration, on the other hand, accompanied by tension, is marked by very characteristic signs. There is often a chill at the beginning, or even a rigor; the temperature rises rapidly, the pulse becomes hard and frequent, the tongue is coated, the appetite lost, the skin hot and dry, the urine scanty and high-colored; headache is always present, and, particularly in children, there is frequently more or less delirium. It is not material whether the suppuration is on the surface of a wound or deeply buried in the tissues; in either case the symptoms are the same, although in the latter they are much more severe, owing to the higher degree of tension. Undoubtedly the chief reason is the absorption of the products of tissue-destruction, poisonous substances produced by the action of the pyogenic micro-organisms.

Round the wound everything is swollen and tense, the skin is hot, red, glazed, and exquisitely tender; often it pits on pressure, and there is œdema spreading up the inner side of the limb along the course of the great vessels, while the pain, especially at first, is violent and throbbing. Later, when the tissues round have recovered themselves and thrown out a protecting barrier of lymph, these local signs become less marked, and at the same time the severity of the constitutional symptoms diminishes; but if, from any cause, the tension is allowed to return, the mischief at once becomes acute again.

The worst complications are those which follow the combination of septic decomposition, tension, and suppuration. If, in such a case as that mentioned already, in which the loose cellular tissue is filled in all directions with extravasated and decomposing blood, a fatal result does not ensue in the course of the first two or three days from sapræmia, and if the patient survives sufficiently long for suppuration to occur under high tension, there is not one of the forms of suppurative inflammation that may not follow; diffuse inflammation of the cellular tissue is certain, but lymphangitis, phlebitis, osteophlebitis, pyæmia, suppurative arteritis, secondary hemorrhage, sloughing, and even gangrene may occur.

## Treatment of Wounds.

In every case the first consideration is to stop the bleeding by measures suited to the circumstances. What these are, and how they are to be used, will be dealt with later on, in considering the injuries of vessels.

The essential points are to make sure that the wounded surfaces are absolutely clean, to bring them into perfect apposition with each other, and to protect them from sources of irritation, whether friction, movement, tension, or the assault of living organisms.

### 1. *Cleanliness.*

Wounds are of two kinds. Some are inflicted by the surgeon in operating, others are accidental. In many respects there is a very material difference.

(1) A wound inflicted in the course of an operation should not require cleansing, except from the blood that covers and obscures the surface. Of course, where old sinuses are present, as in the removal of sequestra, or when the wound communicates with the intestine or the anus, the conditions are entirely different. Everything that comes into contact with the wound or with the skin near it

should be already clean. The operator's hands and arms should be well scrubbed with soap and water and a nail-brush. The skin round the wound should be treated in the same way, and then sponged with a five per cent. solution of carbolic acid. The instruments should be kept for at least half an hour in a solution of similar strength. Special care should be taken about the sponges, which should be kept in carbolic lotion; and nothing but a perfectly clean mackintosh or india-rubber sheet should be allowed near the wound. If these precautions are thoroughly carried out, there is no need to wash the wound out or to flush it with anything, unless it is desirable for the sake of checking oozing. Ovariotomy wounds, operations for hernia, excision of the breast, and amputation of limbs, for example, if the tissues are healthy and fairly well nourished, should heal at once by the first intention.

Contused and lacerated wounds, if they are perfectly clean, heal in the same manner; compound fractures by indirect violence, for example, very rarely suppurate; the dead fragments, which are always more abundant in such injuries, are quietly removed by the leucocytes; but there is more risk. In a simple incised wound the amount of injured tissue is exceedingly small, the structures on either side retain their vitality and power of resistance unimpaired; in contused wounds, on the other hand, the bruising is often considerable for some distance round, and there is always the fear, even if decomposition does not occur, that the pyogenic organisms may gain access to the part, as they sometimes do in subcutaneous injuries, and finding structures already damaged, cause suppuration. The amount, however, is never serious unless there is some further cause—tension, want of rest, or decomposition—continuing to depress the vital power of the tissues around.

(2) Suspicious wounds and those which are known to be infected require an entirely different plan. It is certain that if the bacteria of putrefaction once gain entrance, and there is dead tissue or extravasted blood at the temperature of the body, they will produce a poison which causes very severe constitutional symptoms, lowers the vitality of the tissues, and renders them incapable of resisting the action of other germs. Steps must be taken, therefore, either to destroy the organisms or to remove the material in which they grow, or preferably to do both.

*a.* The first of these indications is fulfilled by thoroughly washing out the wound and scrubbing the skin round with an antiseptic lotion, using an irrigator or a piece of rubber tubing, and passing it down to the bottom of all the recesses. If it is in one of the extremities and otherwise conveniently placed, it is more satisfactory to immerse the injured part altogether in an antiseptic bath at the temperature of the body for two or three hours.

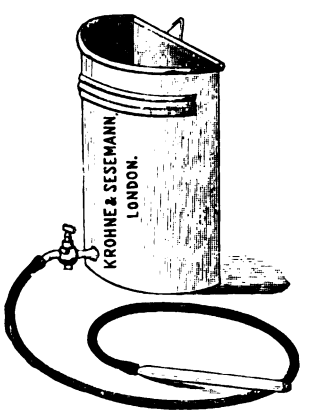



FIG. 24.—Irrigating Can for thoroughly Washing out the Recesses of a Wound.

What antiseptic should be used is to a great extent a matter of personal choice; the ideal one has not been found. Corrosive sublimate, either alone, with chloride of ammonium (sal alembroth), or with a minute quantity of hydrochloric acid, is very effectual. One part in a thousand is sufficient for general purification, one in five or ten for the irrigation; but it should never be employed for large absorbing surfaces such as the pleura or perineum, or for complicated or extensive wounds in which there is any fear of its retention. As a germicide there is no doubt of its value, but it has many drawbacks. Dysenteric diarrhœa, vomiting, collapse, and even death have been known to follow its use; in one case under my care (compound dislocation of the ankle-joint) salivation was caused before the odor of decomposition disappeared; and it ruins any steel instruments with which it comes into contact. Further, it forms an insoluble compound with albumin, which is said to be almost inert, but this difficulty is to a great extent overcome by the addition of chloride of

ammonium or hydrochloric acid. Lister has lately been experimenting with a double cyanide of mercury and zinc (of unknown composition) which may prove more effectual.

Carbolic acid possesses the advantage of being volatile, but it too is by no means perfect. According to Koch, instruments to be absolutely pure should be left for at least two days soaking in a five per cent. solution. One part in forty is the ordinary strength for cleansing wounds; one in twenty for instruments, sponges, etc. Olive-green urine which darkens on exposure to light is not uncommon after its use; headache, giddiness and sickness occasionally occur; and instances of extreme depression with low temperature and fatal collapse have been recorded. Further, it distinctly tends to encourage oozing from the surface of a wound by its action upon fresh blood-clots, and the amount of discharge afterward is always excessive.

Other substances are recommended from time to time, but with very few exceptions they do not appear to obtain general recognition. Boracic acid is practically non-poisonous, and may be used either as a saturated solution in water, or even dusted upon the wounded surface, but it is not nearly so effectual. Thiersch's solution is formed of two parts of salicylic acid, twelve of boracic acid, and one thousand of water. Hydronaphthol is strongly recommended as non-poisonous and as powerful as corrosive sublimate under the conditions of actual practice. It is very soluble in alcohol, but only slightly so in cold water. Salufer succeeds very well in the hands of some, and appears perfectly safe. Eucalyptus preparations are very agreeable at first, but patients are apt to get tired of the smell. Chloride of zinc, which is stated to be almost inert so far as germs are concerned, is undoubtedly of very great value under special conditions.

[Solutions of Bromine and Iodine have each an exceptional value in certain conditions.]

Whatever antiseptic is used, unless it is intended to treat the injury by a continuous bath, or there is some condition rendering it impracticable, it is most important to keep the surface dry and check the amount of discharge as much as possible. Germs cannot grow without fluid. For this reason Gamgee preferred equal parts of spirit and water, a saturated solution of borax with about one-eighth of glycerine and equal parts of water, glycerine, and methylated spirit, to the watery solution of any antiseptic.

This is probably one of the chief reasons why iodoform has met with such favor. Its smell is exceedingly peculiar, very penetrating, and objectionable from its associations; there have been many instances of serious poisoning, and even of death from its absorption; it is by no means certain that it is a germicide; yet as a matter of clinical experience there can be no question that it forms a most valuable dressing for wounds. The hemorrhage is stopped; the surface becomes dry: the amount of discharge is reduced to a minimum, and repair takes place rapidly, beneath the crust that forms, without suppuration or decomposition. It is chiefly used in the form of powder, but it may be dissolved in ether for special purposes, or formed into an emulsion with glycerine, or sprinkled over moist gauze, and then well rubbed into the meshes; and it may be applied to quite recent wounds or to those that are already suppurating. Elderly people are said to be more liable to its effects than others, but, as in some cases very large amounts have been used without any ill result, it is probable the susceptibility depends chiefly upon individual peculiarities. An erythematous rash, sometimes starting from the neighborhood of the wound, sometimes general, is tolerably frequent. Anorexia, headache, and great depression occur in the milder cases; delirium, sleeplessness, and even convulsions in those that are more severe; while in the worst of all the pulse is rapid and thready, the surface of the body cold, and the prostration extreme from the very first. It appears to be excreted by the kidneys as an iodide, and it has been suggested that poisoning only occurs when the action of these organs fails, possibly from the formation of some compound with an albumin.

*b.* The second indication is to keep the wound clean. Germs cannot live

without fluid, and have little or no power on tissues that are perfectly healthy. If the interior of the wound is kept dry, and the vitality of the structures around it is unimpaired, they are practically innocuous.

Unfortunately cleansing a wound with an antiseptic causes other effects as well. All antiseptics injure the tissues they touch to a greater or less extent, and increase the amount of fluid poured out (carbolic acid is probably the worst in this respect, iodoform the best); and many of them are used with water, which, unless it is thoroughly sponged out (again an irritant, of some importance too, especially in connection with the peritoneum), adds still more to the quantity. In a simple incised wound, if the surfaces are brought together and pressure is properly applied, the amount of exudation is so small that it may be left to the natural process of absorption. Contused and lacerated wounds, in which the oozing has been completely checked, may, if not too much handled, be treated in the same way; or at most a little opening may be left at one angle, so that any great excess of fluid can drain off and be absorbed by the dressing covering it. But a wound that has been thoroughly cleansed, and the surface of which has been sponged or washed with strong antiseptics, requires something more. If it is left open, the fluid that is poured out naturally can escape at once; but if the skin is united over it, and no precaution is taken, the interior no longer remains clean; exudation is more rapid than absorption; fluid collects; tension is set up; inflammation follows, and if nothing is done suppuration is certain; the germs gain access to the part, and destroy the leucocytes in just the same way as they sometimes do when a simple bruise is constantly rubbed or hurt.

To keep such a wound clean, therefore, and to prevent tension and its consequences, either the edges of the skin must not be united, or, if they are, a system of drainage must be employed. The method in which this is carried out depends upon the way in which the surfaces of the wound are adjusted and held together.

### 2. *Apposition of the Wound Surfaces.*

Want of cleanliness is altogether fatal to repair: the tissues cannot close the wound until by the production of vascular granulation-tissue they have ejected all injurious agents, at a certain sacrifice. Given cleanliness, the rapidity with which repair is effected depends upon accuracy of apposition. Irregular injuries with uneven cavities are gradually filled from the bottom and the sides, but the process, in comparison with those in which the surfaces are properly adjusted, is very slow, and the amount of cicatricial tissue much greater.

Accuracy of apposition is effected by attention to position, pressure, sutures, and strapping.

**Position.**—In operations, incisions are planned to avoid tension and to allow wounded surfaces to fall together of themselves. Natural folds are followed as far as possible, and gravity is carefully considered with regard to the attitude of the patient. In chance wounds, the position of the body and limbs must be arranged to suit the circumstances. A great deal can sometimes be effected by this, but it must be recollected that discomfort may cause fever. In many plastic operations the position of the patient has to be fixed, and this cannot be avoided.

**Pressure.**—Properly applied, this is of the greatest assistance. It keeps the deeper parts of the wounds together as well as the superficial ones; prevents the formation of a cavity in which fluid can collect; checks the tendency to effusion, and assists the absorption of that which has already been poured out. Every structure in the body exists under a certain degree of tension; as soon as the skin is divided, this disappears; and one object of the dressings applied to a wounded surface is to restore it to its natural condition until repair is completed.

The ideal dressing is perfectly soft, elastic, absorbent in the highest degree, and impregnated with something that will make it safe against putrefaction without rendering it in the least irritating. If these conditions are fulfilled, and if

abundance of the material is used, an amputation wound, or such a one as is produced in arthrectomy, may often be left a fortnight, or even longer, untouched, and only two or three dressings at the most are required. Absorbent cotton-wool, wood-wool wadding, treated with corrosive sublimate, prepared moss, and sponges wrung out of carbolic (the last especially if elastic pressure is required to stop hæmorrhage) are the most useful. A strip should be laid on either side of the wound, some little distance from the edge, so as to press the deeper parts well together, and, as it were, force the actual line somewhat outward; and then all the space round and in between should be thoroughly and carefully packed, especial attention being paid to the hollows between the bones. Over this a soft elastic bandage is placed, without reverses; or if a greater degree of firmness is required, torn strips of mill-board, soaked perhaps in plaster cream, as recommended by Gamgee, and then the bandage over these. The ease and comfort of this arrangement can hardly be surpassed. Immobility is perfect; the patient feels that all is secure; tension is prevented; there is no cavity in which fluid can collect; the small amount that is not taken up by the tissues is driven through the edges of the wound and harmlessly absorbed at once; vascular dilatation cannot take place to excess, and the apposition of the injured surfaces is as exact as it is possible to make them.

**Strapping.**—This is either employed in superficial wounds by itself, or in deeper ones as an adjunct to sutures, for the purpose of distributing tension and of immobilizing structures on either side. In operations on the breast, for example, one or more broad strips may be advantageously brought up from the region of the back to support the lower flap, draw it upward, taking the tension off the sutures. and keep it firmly pressed against the ribs.

**Sutures** are of various kinds and various materials. Catgut of different degrees of thickness and hardened more or less in chromic acid, according to the strength and endurance required, is the most useful. Silver or iron wire possesses the advantage of being absolutely unirritating and of being easily fastened, but requires removal; and the same may be said of silk. If properly prepared, and so arranged that no tension falls upon them, any of these materials may be left for weeks without causing the least irritation; but wire and silk almost always require to be removed at last; catgut removes itself.

Silkworm gut, softened beforehand in carbolic lotion, so that it will tie more easily, is especially useful for plastic operations. Horsehair is occasionally employed where there is no tension; and in comparatively rare cases other materials are used as well.

The method is still more variable; the object is to secure accurate adaptation of the whole depth of the wound without causing tension upon it anywhere. In deep-seated or complex injuries this is only possible by means of *buried sutures*, which must necessarily be of catgut. Layer after layer of tissue is accurately adjusted and secured *in situ*, periosteum to periosteum, muscle to muscle, and fascia to fascia. The deepest sutures are fastened the most firmly; the superficial ones are not so tight, so that if anywhere the amount of effusion (owing to some accidental source of irritation) is in excess of absorption, the fluid may make its way in the direction of least resistance, toward the surface. It is only by means of this kind that large and complex wounds, those for example left by amputations, can be safely secured without drainage; but, of course, the surfaces must be perfectly clean and healthy, fit and ready to cohere together at once. In the presence of suppuration or of decomposition, sutures used in this way could only lead to the most disastrous consequences.

Deep sutures (*sutures of support*) aim at effecting the same result, but at the expense of tension and pressure upon the skin some little distance off. *Button sutures*, for example (Fig. 25), are cut from pieces of stout sheet lead of various shapes and sizes. One of these is placed on either side of the wound, some little distance away; and while the two are brought together as closely as is thought desirable by the hands of an assistant, a stout silver wire is passed deeply

across from one to the other, and fastened in a slit cut in the side of the lead. This relieves the edges of any tension by transferring it to a greater distance and spreading it over a wider surface; but, though they are useful in such operations as excision of the breast, they do not secure nearly the same accuracy of apposition for the deeper parts. The same may be said of the *quill suture* (Fig. 26), in which longitudinal rigid supports are laid a little distance from the edges of an incised wound and fastened to each other by deep ties of wire or some other unirritating material. Strong curved needles set in a handle are required for them; the skin and the deeper structures are transfixed, first, on one side, and then, in the opposite direction, on the other; if the needle is threaded before it is passed the loop is caught and drawn out, so that a double suture is left; if not, it is threaded when the point projects through the skin on the further side and withdrawn, carrying the suture with it. As a rule such sutures cannot be left more than four or five days, but everything depends upon the degree of tension. Their chief object is to prevent any strain upon the superficial ones, and as soon as these appear secure they should be cut, even if they do not require it of themselves.

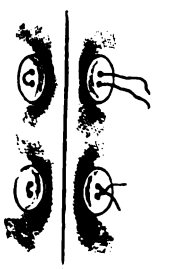


FIG. 25.—Button Suture.

The *twisted* or *figure-of-eight suture* is chiefly used after removal of part of the lip in order to bring the whole thickness of the cut surfaces into apposition. It is very rarely required for simple harelip, sutures of silkworm gut being nearly always sufficient. Steel pins, silvered over, are introduced about half an inch from the margin of the wound; passed obliquely down through the whole thickness on

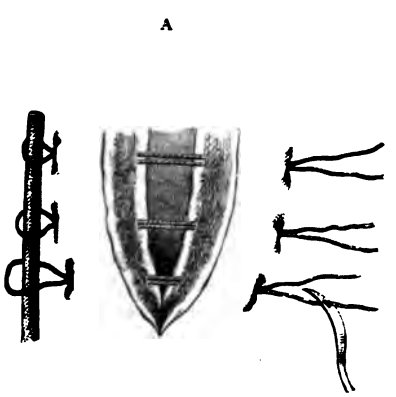


FIG. 26.—The Quilled Suture.

A B

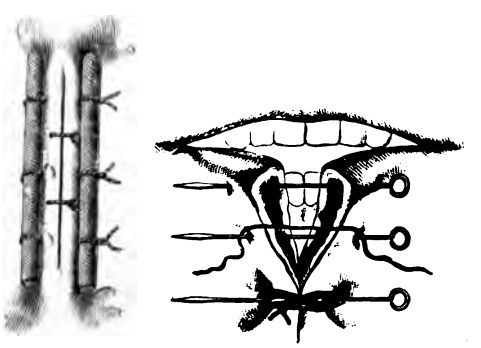


FIG. 27.—The Twisted Suture.

one side as far as, but not through, the mucous membrane; then carried across the cleft (Fig. 27), made to enter at a corresponding point on the other side, and passed through to the cutaneous surface, piercing the tissues in the opposite order. The surfaces are then brought together by lateral pressure and a piece of stout silk twisted round the projecting ends in a figure-of-eight. The point and the head of the pin (if it projects too far) are cut off with pliers; the skin beneath is guarded with a small piece of lint or strapping; and the whole is left exposed to the air so that the blood may dry upon the surface and form an additional protection. The pins should be removed in forty-eight hours, or suppuration is almost sure to occur round them, and the marks caused in this way may be more conspicuous than the linear cicatrix of the operation. If possible they should be withdrawn by twisting them round, so as to leave the silk with the coagulated blood still adherent to the surfaces of the skin. If it comes away, strapping must be used as a support.

Superficial sutures are interrupted or continuous, and may be of any material —catgut, wire, silk, or horsehair. Ordinary straight needles with triangular points, or Hagedorn's curved ones (which are flattened from side to side, not like the ordinary ones from above downward), are the best, the edges of the wound being raised well up with the finger and the thumb, so that the needle may be passed at one thrust through both.

In the *interrupted suture*, the material is cut, and knotted or twisted as the case requires, each time the incision is crossed, care being taken that the knot always lies to one side and that there is no dragging or puckering of the skin. The object of a superficial suture is not to draw the two edges together (this should be

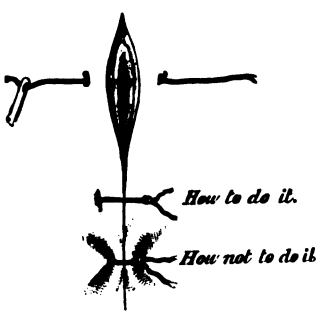



FIG. 28.—The Interrupted Suture.

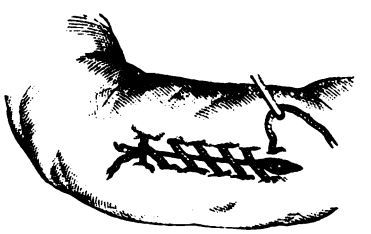


FIG. 29.—The Glovers' Suture.

done by pressure, position, or other means), but to hold them, gently but firmly, facing each other. In all cases the knot should be a true one (Fig 28).

In the *continuous suture* there is only one knot at each end, or if the line is very long, one here and there. The varieties are almost endless. The common one is the ordinary *glovers' stitch* (Fig. 29), simply over and over. Or this is modified by using a double thread, except for the first perforation and the last; these have only a single one, so that two ends project from the skin, one on either side of the wound at its two extremities, and the suture can be made secure at once by tying them together across the line.

In *the quilt suture* (Fig. 30) the needle is carried through the two flaps, and then back again, so that a loop is left on one side, and the two ends on the other. These two ends can either be secured together at once; or one may be carried in the same manner along the whole length of the wound. Sometimes this is combined with the glovers' suture; an outside row of quilt stitching is carried along the whole distance to draw the flaps together, and then a line of glovers' is brought back along the edges to secure accurate apposition. The two ends of the thread are thus brought close together, and may be tied at once. This is exceedingly useful in cases in which tension is feared, but as a rule the outside row requires division on the third day.

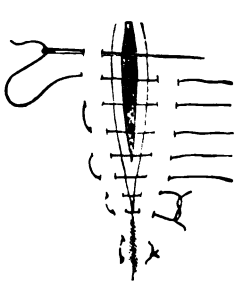


FIG. 30.—The Quilt Suture as Applied to the Intestine.

The great advantage of the continuous suture is the rapidity with which it is applied and the accuracy it ensures. There is, on the other hand, the serious objection that if from the presence of tension at one single spot it must be cut before the wound has healed, the whole is likely to give way. Of course, it should never be employed by itself as a circular suture round the intestine or any other hollow tube, as it would become loose at once if this collapsed.

Other forms of suture, Lembert's, Jobert's, etc., are described in connection with special operations.

**Drainage.**—The question of drainage depends upon the character of the wound. After any injury, no matter how simple, the amount of exudation is in excess of absorption. If the difference is only slight, the tissues, aided by judicious pressure and rest, are able to deal with it after a little time, and the balance is restored. If, however, the difference is considerable, and no exit for the surplus provided, there is a certain degree of tension; this inflicts a fresh injury, and inflammation follows.

(*a*) *Simple Incised Wounds.*—If the bleeding is stayed (at least that from vessels of any size, for too much care may be shown in this matter and more harm done than good), the surface clean, and apposition accurate, there is the minimum of exudation; absorption begins at once; and provided no fresh injury is inflicted, the balance is restored again almost immediately. The least friction or movement and it is all undone.

(*b*) *Contused and Lacerated Wounds.*—Accurate apposition is often impossible; a cavity is left which must be obliterated by the growth of vascular granulation-tissue from the sides and bottom. Whether drainage is required or not depends upon the character of the wound and the amount of irritation to which it is subjected.

Supposing it is perfectly clean and there is sufficient skin to cover it in, the wound as soon as it is left fills with blood and lymph from the dilated vessels around, until the pressure in the interior is equal to that exerted by the dressings over it; in other words, it is almost in the same condition as a severe contusion. The sole difference is in the amount of fluid; in the one case the pressure of the unbroken skin limits the exudation from the first, and there is no source of irritation other than the tension; in the other, owing to exposure to the air, manipulation, the application of dressings, and other causes, even when everything is absolutely clean, the quantity is very much more abundant, and the absorbing power less. Accordingly, it is usually advisable to provide some means for escape, at least for the first twenty-four hours; either the edges of the wound are left slightly separated at one spot and an absorbent dressing applied; or, if it is thought that is not likely to be sufficient, a small drainage-tube, a few threads of horsehair, or a few strands of catgut, are placed in the cavity with one end projecting from the wound. At the end of twenty-four hours all excess should cease, and, if a fair amount of pressure is kept up over the wounded surface, absorption should balance secretion.

If the skin is insufficient, so that an open wound is left, the same plan may still be tried, only now an artificial protecting covering must be formed. In small wounds which can be kept at perfect rest this may be done with iodoform; the powder is dusted over the glazing surface, a dry scab forms, the wound is absolutely protected, and the pressure is sufficient to check the exudation. In larger ones an attempt may be made in the same direction by what is known as Schede's dressing. Immediately over the wound is placed some fine rubber or gutta-percha tissue, perfectly clean, but not moistened with carbolic; it should be just large enough to overlap the edges of the wound. This is covered with a thick layer of some absorbent dressing (impregnated with an antiseptic to act as an additional safeguard against putrefaction) and the whole is then firmly and evenly bandaged over. The outer dressings absorb the surplus serum that exudes from the lymph that fills the wound, and the thin film of rubber tissue acts as a scab to protect the surface.

(*c*) *Irritated and Foul Wounds.*—Where there is perfect cleanliness, and the parts are kept absolutely at rest, these methods answer admirably and nothing more is needed. If apposition is not quite accurate, if there has been much bruising or handling, or if the wound has been foul and has been subjected to a thorough cleansing, the amount of lymph that is poured out is at first too great for absorption, and an escape must be provided. The cause, however, is only a temporary one, and generally, if the dressing is absorbent, a dependent opening is all that is required. Sometimes a small drain is advisable, but after the first

twenty-four hours all excess should cease (there being nothing further to cause it), and uniform compression with an absorbent dressing should be sufficient.

This is not the case when the irritation is continuous, whether it is due to the wound remaining foul, or to its being subjected to constant friction or other source of irritation. The cause is then a continuous one, fresh injury is constantly being inflicted upon the tissues, and the amount of exudation continues to increase to a degree that is only regulated by the extent and intensity of the irritant. This fluid, in its turn, if the wound is closed, affects the already injured tissues by the tension that it causes, or, in the case of septic decomposition, as well by the poisons it contains; the wound becomes hot and swollen, the pain much more severe, the temperature rises, and, unless the most ample provision is made for free and continuous escape, some form of suppurative disease is certain. Drainage acts in two ways. It diminishes the tension, relieving the pain and checking the absorption of poisonous fluids from the interior, and it stops septic decomposition by drawing off the fluid on which the germs grow and gradually starving them out.

Chassaignac's tubes have never been improved upon, except in the quality of the rubber. They are of any length and of any diameter, the sides perforated with openings here and there, and sufficiently strong not to collapse. In using them, one end should be passed down to the bottom of the cavity, the other brought out through the wound at the most convenient spot and cut flush with the skin. It is better that they should point downward for the sake of gravity, but, provided the outside pressure is properly arranged, there is no absolute necessity for it. The end should be secured with a silk ligature or a "safety" pin, so that it may not slip inside altogether. One or more may be used, according not so much to the extent of the wound as its complexity, and care should be taken that they are sufficiently large; small ones are filled with blood-clot almost at once, and are often injurious from the false sense of security they give. When not in use, drainage-tubes should be kept in a five per cent. solution of carbolic acid.

As a rule, if the wound surface was clean, a drainage-tube may be removed at the end of twenty-four hours. If there was much oozing, it will be filled with clot; if there was not, it is not required any further. Whether it should be introduced again for a part of the distance—through the skin, for example—depends upon the amount of discharge, the degree of tension, and the presence of layers of fascia which might render the opening valvular. If the injury was from the first suspicious, or if there is any fear of septic decomposition or of suppuration, and the edges of the skin have been brought together, it should be replaced and only shortened by degrees as the cavity fills up.

As it is not unfrequently necessary to dress a wound on the day after an operation, solely for the purpose of removing a drainage-tube, many attempts have been made to dispense with their use, or to employ only such as are spontaneously absorbed. Buried sutures cannot be recommended except when the wound is a clean incised one, and then they are rarely wanted. Neuber's decalcified bone tubes cannot be relied upon, and the chicken-bone drains of MacEwen are only to be trusted in special cases; the rate of softening is not uniform, and irregular pressure may cause kinking. Catgut drains are rarely employed; they do not really exert any capillary attraction, and they tend to block the opening by softening and swelling up. Horsehair is a little better, but if a drainage-tube must be used in these cases (and it is very questionable whether, when the amount of discharge is so small, it would not be better to trust at once to the absorptive power of the tissues under uniform compression), a thin slip of gutta-percha tissue is better than any. It is not so likely to become displaced, it prevents the edges of the skin uniting, and by its irregularity forms a kind of trough along which the fluid can escape.

Of itself the mere presence of a drainage-tube is so mild [illegible] whenever there is the least suspicion as to [illegible] tion should be adopted.

### 3. *Protection.*

Open wounds require protection from without even more than from within. The surface may have been absolutely clean at the time of the operation and may have been protected from all possibility of tension or of other sources of internal irritation afterward, but this is not sufficient; other irritants may gain access to it from the outside, and if speedy union is desired the wound must be made equally secure against these. The chief are friction, movement, and the presence of certain micro-organisms, especially those of putrefaction. These in particular, if they can find a suitable soil in the neighborhood of a wound, are almost certain to work their way into the interior, and, once there, make the secretion decompose.

The essentials of a perfect dressing are not difficult to enumerate, though they are not so easily found in combination. It must be perfectly soft, absolutely unirritating to the most delicate structure, sufficiently elastic to keep up an equal degree of pressure all over, utterly unable itself to undergo decomposition, and capable of absorbing an indefinite amount of albuminous fluid without clogging. Wood-wool wadding prepared with corrosive sublimate, salicylic wool, absorbent cotton-wool, and other similar substances answer these requirements fairly well, and they possess the advantage of being cheap at the same time, for, although a dressing of any one of these materials may and often does last for a fortnight without being changed, a considerable quantity is required each time, especially in the case of large wounds.

In some instances in which a raw surface or a fresh blood-clot is left uncovered by skin, a thin piece of rubber tissue, a shade larger than the wound, should be laid over it, to prevent the dressing becoming too firmly adherent, or by its absorptive power desiccating the tissues too deeply; in all other cases it should be placed immediately upon the skin. No water-proof or air-proof covering should be laid over it; the albuminous secretion of the wound is absorbed and becomes dried at once, forming a protective covering which, if undisturbed, is absolutely impenetrable to any germ. The amount of pressure to be used in each case can only be judged of by experience; if, however, the dressings are of sufficient thickness, it can scarcely be too great. The firmer it is (always provided it is perfectly uniform and falls upon the right parts) the greater the degree of immobility and the less the risk of tension or of the accumulation of discharge. [Immobility may be secured in many cases by applying a light plaster-of-Paris dressing over the other dressings.]

### Subsequent Treatment.

The subsequent treatment of a wound is regulated altogether by the complications that follow. If all the conditions essential to speedy repair are perfect, the dressing need not be changed until it is united. An ovariotomy wound, for example, is often healed before the dressings are removed. Catgut sutures are absorbed so that the knots come away of themselves; silk or wire ones must be cut, but so long as there is no tension upon them they lie perfectly inert in a wound that heals at once. [Silkworm-gut sutures uniting skin wounds may remain longer.]

If, owing to the amount of oozing, it is thought advisable to use a drainage-tube, the dressing must be changed, as a rule, before the third day, for the sake of removing it. I have often left them a week without harm, although occasionally the newly-formed lymph that surrounds them is bruised and made to bleed as they are withdrawn; but unless the wounds are badly contused or have been subjected to [illegible] of manipulation, they are of little benefit after twenty-four hours, and not cause any actual mischief. In wounds that are foul, of different.

matic fever is to be expected in the case of any large
ly drop two or even more degrees the evening after

an operation, or it may begin to rise at once; the next morning in the milder cases it is normal, in those that are more severe it may be 101° F. (38.3° C.), but its highest point should be reached within thirty hours. If it does not begin to subside then (it may, even in subcutaneous injuries, take nearly a week before it drops to the normal) it means either that there is some degree of tension, whether arising from tight suture or from an unexpected amount of oozing, and that it had better be relieved, or else that the precautions have failed, that decomposition has begun, and that septic fever is commencing.

### Special Kinds of Wounds.

Punctured wounds inflicted with a perfectly clean, sharp instrument require the same treatment as incised ones; the only fear is the difficulty of excluding injury to deep-seated structures; the bladder, for example, may be penetrated through the sacro-sciatic foramen. Even if the instrument was blunt, so that the edges are contused, the same plan may be adopted; the wounds caused by small revolver bullets nearly always heal readily if they are not interfered with and no fragments of clothing are carried in. But if the weapon was foul, it is better to enlarge the opening at once, sponge it out with an antiseptic, and drain it thoroughly. If this is not done the surface is very likely to heal, while deep-seated suppuration under high tension occurs beneath.

Subcutaneous section is often employed by surgeons when it is wished to divide important structures, such as tendons, fasciæ, or bones, for the purpose of correcting deformity. A minute puncture only is made through the skin at some specially chosen spot, frequently at a little distance from the part to be divided, if that enables it to lie in one of the natural folds or avoid important structures with greater certainty. Then the instrument, a saw, chisel, or fine tenotomy-knife, as the case requires, is pushed in and the division effected with as little disturbance of the structures around as possible. The wound is closed with some absorbent dressing and the part carefully packed and bandaged, or placed upon a splint. If the instrument used is perfectly clean and no tension, friction, or undue movement allowed, the wound heals immediately without any more risk of suppuration than in a contusion treated with similar precautions.

Open wounds are exactly the opposite; there is not sufficient skin to cover them in, and they have to heal by granulations from the side and base. If they are well protected from all sources of irritation none of the leucocytes are wasted as pus, the whole of the lymph becomes organized—the deeper part into some form of connective tissue, the more superficial into epithelium.

Contused and lacerated wounds have been described already. They are especially serious, both from the widely-spread injury sustained by the tissues, and the difficulty of ensuring thorough cleansing. If the structures round are badly hurt, a certain degree of suppuration is not uncommon, even when the wound is perfectly clean; the injured tissues are unable to withstand the assault of the pyogenic microbes; but the result under these conditions is never serious, unless there is tension, or decomposition, or some other persistent irritant. If these occur there is no limit to the consequences that may follow.

Infected wounds must be thoroughly cleansed with corrosive sublimate or chloride of zinc, and then, according to their character, either dried completely and covered with iodoform, any accumulation being prevented by the use of drainage-tubes and absorbent dressings, or left widely open so that there may be no retention of discharge. If the tissues are the stronger, a barrier of vascular lymph gradually forms, and as it organizes, closes the wound; if, on the other hand, the are enfeebled from intemperance, Bright's disease, or any other cause, or if the action of the poison is assisted by tension, want of rest, or any other irritant process of destruction continues to spread.

## CICATRICES.

A cicatrix or scar is the splice of fibrous tissue formed by the organization of the lymph that fills a wound. At first it is soft and vascular; then, as the fibres of which it is composed contract, it becomes dense and hard; the newly-formed vessels disappear, and only a dead white inelastic layer is left. There are no lymphatic or elastic fibres in it; the surface is smooth, formed of a few layers of epithelial cells; no papillæ, hair-bulbs, or glands are ever developed if once they have been destroyed; and except in certain cases there is no reproduction of special tissues. As time advances and the cicatrix continues to contract, it may gradually (at least in the case of union by the first intention) merge into the surrounding tissues and almost disappear; or, on the other hand, it may become more and more conspicuous and lead to the most fearful deformity.

FIG. 31.—Effects of Burn on Neck, Contraction of Cicatrix.

This depends chiefly upon its amount. In wounds that heal by the first intention there is exceedingly little (in what used to be called immediate union it was said there was none at all); in those in which the amount is greater, as when some of the skin has been destroyed, a certain degree of contraction usually follows; and where the cavity was a deep one with a fixed base (formed of bone or fascia) an unsightly depression may be left; but it is only when suppuration occurs, and the destruction involves a considerable extent of surface, that the full effect is produced. Burns that destroy the whole thickness of the true skin often leave the most fearful deformity. The arm may be tied down to the side, the lower lip (Fig. 31) dragged down to the sternum, the eyelids pulled down or else completely

FIG. 32.—Contraction of Cicatrix After a Burn.

closed, the mouth contracted to an orifice so narrow that the patient is scarcely able to feed himself, and the œsophagus converted into a fibrous cord for the outer part of its length. The contraction begins in the deeper layers of the granulation-tissue long before the wound has closed, and where the true skin has been destroyed it progresses steadily and relentlessly,

taking advantage of every momentary neglect, and never giving up the ground it has once gained until in many cases further shortening is physically impossible.

This tendency can be checked to some extent while the wound is healing. Prolonged suppuration undoubtedly favors it, and much may be done to prevent this by epidermic grafting, although the result is often very disheartening. Splints and other appliances can be used to retain the limbs in suitable positions, but as a rule it is necessary to continue their employment a long time after the tissues have healed, and, as a matter of fact, whatever is done, the steady persistence of the cicatricial tissue is almost sure to gain the day at last, especially if the injury involves the flexor surface of a joint (Fig. 32).

The best hope then lies in plastic surgery, the transplantation of a flap from some other part of the body into a space made by the division of the cicatrix. Mere section seldom is of much use. There are two ways in which this may be effected, but in both the whole depth and extent of the cicatrix, at least from one side to the other, must be thoroughly excised, an operation requiring great care, as not unfrequently all the important nerves and vessels of a limb are entangled in it. In one of the fashions perfectly fresh flaps of skin are used, left attached at one end, or preferably at both. The outline must first be carefully marked out, and then the skin and subcutaneous tissue divided down to the aponeurosis leaving a base sufficiently broad for nutrition, and if possible including the chief vessels. As a rule, the length should not exceed three times the width, the measurements being taken before the operation is begun. Then the flap is carefully dissected up, laid in position, and secured accurately by sutures all round the free margin. If it is only left attached at one end, it must be twisted into the required situation, care being taken not to strangulate it; if at both, so that it forms a kind of bridge, the raw surface must be placed beneath it; a strip for example, may be dissected up from the thigh, leaving it attached at both ends and the forearm slipped under. Then the whole must be made absolutely secure by means of plaster bandages, each part being bandaged first, and then the two fixed together. The time when the pedicle may be divided depends upon the degree of union. If the surface of the flap has formed definite cohesions to its bed, it may be done as early as the eighth day; in most cases, however, especially if the margins only have united, it is better to wait fourteen; and when the pedicle has been much twisted, and the vitality appears low, longer still. MacCormac has used a constricting india-rubber band round the pedicle for some days previous to division, so as first to establish to some extent a collateral circulation.

FIG. 33.—The Same After Incisions and Extension.

In the other fashion the same precautions are adopted, but the flap is dissected up first, separated from its natural bed by a strip of gutta-percha tissue, and left to granulate all over its under surface; then, at the end of two or three weeks, as the case may be, when it is thick and vascular, it is transplanted into the prepared site. In the meanwhile it shrinks to comparatively a very

expands again to some extent afterward. Union between the freshened surface and the layer of granulations apparently takes place without any difficulty; and as there is less fear of sloughing, the pedicle can easily be detached rather earlier than when a fresh flap is used.

Minor degrees of contraction may be treated by means of extension (provided sound skin can be found above and below, on which to fix the apparatus); by simple division, and extension afterward, or by multiple incisions, as, for example, in the case of the fingers, when numerous V-shaped cuts may be made along a contracting scar, and the edges brought together from side to side. Occasionally a long and narrow cicatrix can be dissected out with the view of securing primary union in its place.

FIG. 34.—Case of Epithelioma Growing from a Cicatrix. (*From the Editor's Work on Tumors.*)

Cicatrices are liable to various diseases, some of which at least are due to their feeble vitality.

*Ulceration* is the most common. On the legs, especially, the scars that are left by chronic varicose ulcers rarely last any length of time; the same causes continue at work, and even when the original wound heals over, it is quickly reopened by the breaking down of the lowly organized cicatrix. The scars of extensive burns may remain unhealed for years.

...e due to a nerve-filament caught in the ...ot which gives an almost electric ... to a kind of malnutrition, the

cause of which is not known. There is a constant burning pain, but the scar itself is as cold as ice, the skin all round is glazed, and does not fall into its natural folds; the color is a dusky livid red, returning very slowly after compression, and the whole part feels hard and dense. Usually this is met with after amputations, and it may return again and again, even when the whole stump is taken away and fresh flaps formed from the natural skin above.

*Itching* is sometimes complained of, and may be described as simply intolerable, without any cause being found. Probably it is due to irritation of some of the nerve-filaments in the cicatrix, or it may depend upon the condition of the circulation. Heat usually relieves it, but in some cases cold and compression answer better.

*Hypertrophy* is very common, and passes by imperceptible steps into what is known as *cheloid*. Addison's or true cheloid must be clearly distinguished, as it is of an entirely different character. This variety forms a firm, hard mass, with a more or less rounded surface, from which spurs and branches run out in all directions. The general outline is most irregular; as a rule, it is smooth and glossy on the surface, with a few dilated capillaries here and there; but often the spurs are perfectly white. It is rarely tender when touched, although it may be the seat of the most persistent itching. It consists of nothing but a closely packed mass of fibrous tissue, with bundles running for the most part parallel to the surface, without definite outline.

*Cheloid* may occur in any cicatrix, and at any time after its formation. I have known it develop after a blister; but it is more common after burns than anything else, especially if there has been prolonged suppuration. Smallpox scars are not unfrequently attacked by it, and in some instances, in which the marks are close together, the whole face is transformed into a dense, rigid mask, perfectly expressionless, and covered with seams and livid nodules. It is not uncommon to find it attacking several scars at the same time; and I have known it occur in four members of the same family. There is no cure for it. Excision is rarely practicable, and even when it is possible, it is almost certain to be followed by recurrence.

*Epithelioma* not uncommonly develops from cicatrices; and sometimes, especially in the leg, it extends deeply into the subjacent structures before it is noticed by the patient. Enlargement of the lymphatic glands does not occur so soon as in some of the other varieties, but the treatment is the same.

## CONSTITUTIONAL SYMPTOMS.

These are divided into three stages corresponding to different periods.

1. *Collapse.*—Extensive burns, even if they are superficial, are followed by the most profound shock. In some the prostration is complete from the first; pain is not felt, there is only a sensation of intense cold and thirst. In others there is persistent restlessness, with vomiting or low delirium, and in children convulsions. The collapse may continue for twenty-four hours or even more, the pulse gradually growing weaker and weaker, or reaction may set in. If this is long delayed the prognosis is very unfavorable.

2. *Reaction.*—As the shock passes off the temperature begins to rise and fever commences, caused no doubt to some extent by the pain and the reflex irritation of the heat centre, but chiefly by the altered condition of the blood and the absorption of morbid products from the wounded surface. If the burn is thoroughly covered up, away from the air, so that the ends of the nerves are not irritated, and there is no putrefaction, the rise of temperature is only slight, and subsides in the course of a few days. If, unhappily, this is impracticable, as it usually is in extensive injuries, septic fever follows, the temperature rises higher and higher, and either sapræmia with some form of internal congestion proves fatal, or after a long illness the tissues gradually gain the upper hand, throw out a barrier of granulations, and check further absorption.

It is in this stage that abdominal and thoracic complications, pleurisy, pneumonia, enteritis, duodenal ulceration, peritonitis, etc., are most common, although they are not confined to it. Sometimes the symptoms are characteristic, short, hacking cough, with rusty, blood-stained sputa, for example; more frequently there is nothing definite, merely a continued high temperature, with quick, feeble pulse, and rapidly failing strength.

3. *Suppuration.*—This is no more essential to the healing of burns than it is in the case of other wounds; a cautery plunged into a nævus leaves a deep cavity with blackened, charred edges, which, if protected from the air, heal over without a trace of pus. In most cases, however, owing to the enormous extent of surface and the conditions under which burns occur, it is practically impossible to prevent the access of living organisms, and the surface of the granulations thrown out by the tissues around always melts away. In not a few this seriously increases the depth of the injury, the tissues that might have otherwise recovered yielding before the combined effects of septic decomposition and suppurative micro-organisms.

The stage of reaction passes into that of suppuration without any definite line; the transition is usually placed at about the end of the second week; the temperature begins to fall in the morning, and if no internal complication sets in, the continued fever subsides and becomes remittent. This continues until the granulating surfaces have healed. After a time the danger of visceral trouble diminishes, but hectic, exhaustion, amyloid disease, and other complications that occur in connection with large suppurating wounds are always liable to follow.

**Pathology.**—Fully half the cases that die prove fatal from shock within the first forty-eight hours, the post-mortem appearances presenting nothing that is characteristic. In the second period, from the end of this time until suppuration has set in, congestion, or sometimes inflammation, of internal organs is often present. In the earlier part the brain is chiefly affected; later the thoracic and abdominal viscera suffer most; and associated with this in a certain proportion of instances (16 out of 125 collected miscellaneously) is a peculiar lesion, ulceration of the duodenum. This has been found as early as the fourth day; it is most frequent in the second and third weeks, but it may occur much later.

There is no really satisfactory explanation either for the congestion or the ulceration. The former has been assigned to reflex paralysis of the walls of the vessels; to paralysis of the heart from over-heated blood; to capillary embolism; to changes in the blood produced by evaporation from an extensive denuded surface; and to retention of poisonous nitrogenous compounds that are usually

excreted by the skin. Except the first of these, however, none has much to commend it; the degree of congestion is not in any way proportionate to the extent of the injured surface; small burns are sometimes much worse in this respect than large ones; and burns on the trunk are always more liable to pulmonary and intestinal complications than others. The severity of the shock is probably the most important factor; its effects by no means disappear when the temperature rises; the vitality of the tissues remains depressed for many days; they no longer possess their normal power of resistance, and any fever-causing substance absorbed from the wound is sufficient to excite an attack of diffuse inflammation.

Ulceration of the duodenum is equally hard to explain. It is not connected with Brunner's glands. The ulcers are perfectly indolent, as if simply punched out, and are usually situated immediately below the pylorus, rarely beyond the bile-duct; there may be only one, or there may be several, either separate from each other and circular in shape, or fusing together. The margins are sharply cut, and the centre is deep, sometimes extending through all the coats into the pancreas, or opening up a large artery or the peritoneal cavity; sometimes, on the other hand, cicatrizing over, showing that the complication is not always a fatal one. There may be very great congestion of the duodenum around, but it is not invariable, and they may occur after burns of any size, or in any locality, although they are more common when the trunk is involved. The most reasonable suggestion appears to be that they are due to the action of the gastric juice upon some part of the mucous membrane in which the circulation has been arrested by congestion or by embolism. It is urged in support of this that they are rarely found beyond the orifice of the bile-duct; but it is singular, to say the least of it, that the congestion or embolism should not also sometimes occur in the stomach. It may be present without symptoms of any kind, suppurative peritonitis setting in suddenly and proving fatal almost at once; or there may be diarrhœa with melæna, epigastric pain, tenderness, and vomiting of dark brown fluid.

Burns of the chest, abdomen, and head are much worse, both as regards symptoms and complications, than those of similar degree upon other parts of the body. In children and old people the prognosis, as might be expected, is much more grave; but the factor that is of most importance in estimating the risk to life is the extent of surface. A deep burn, if it is limited, is often only a local affection; a very superficial one, on the other hand, caused by momentary exposure to intensely heated air or steam, if it involves a large area, will almost certainly prove fatal from shock, or, if the patient survives this, from subsequent internal congestion. When the face is much burnt there is always the danger that the mucous membrane of the larynx may have been injured at the same time, and that œdema of the glottis and broncho-pneumonia will follow.

**Treatment.**—In a large superficial burn, the first thing is to prevent the patient sinking from collapse; under the influence of the shock the temperature falls, the circulation becomes feeble, the amount of heat and energy produced by the tissues diminishes, and death may ensue simply from the failure of power. Warmth, stimulants, and opium are the chief remedies. The heat of the body must be economized in every way, pain relieved as far as possible, the heart prevented from failing, and the tissues supplied with diffusible stimulants which will help them for the time to do all that they can. If it can be managed, the patient should be placed at once, without waiting to take off clothes that are adherent, in a warm boracic bath, the temperature of which is carefully maintained; and provided the inhalation of the hot vapor is prevented by surrounding the neck with a mackintosh or other waterproof material, he may be left in this for some hours until reaction begins. Meanwhile the burnt fabrics will float off or can be cut away, without injury to the parts beneath or exposing them to the air. As soon as the pulse begins to recover, all the injured part should be wrapped in many layers of boracic lint or salicylic wool, and enveloped with a bandage, a certain degree of soft compression being used. Carbolic acid is much too irritating for burns, and

corrosive sublimate applied to an extensive surface would very probably prove dangerous.

Thirst may be relieved with milk and soda water, or very dilute acid drinks. How long stimulants are necessary must be determined by the condition of the pulse, but care should be taken not to push them too far or to continue them too long; as soon as there is a distinct improvement in the arterial tone, small quantities of beef-tea should be given with them, and should gradually replace them; but, throughout, everything must be done to maintain the strength of the patient. The visceral congestion and inflammation that occur in the second period, that of reaction, are distinctly encouraged by everything that tends to reduce the already weakened reserve; and after this stage is passed, and suppuration has set in, the question of recovery or not often turns upon the balance that is left, and the way in which it can be economized.

Diarrhœa should be checked at once with opium and dilute mineral acids. Pulmonary complications must be met with ether and carbonate of ammonia. If vomiting occurs, it may sometimes be relieved by very minute doses of vinum antimoniale, or the stomach may be left entirely empty for a time, and nutrient enemata given instead. Bromide of potash is often necessary in cases in which there is delirium, or evidence of commencing cerebral congestion, and quinine, tonics, and especially iron, in the later stages, if the appetite is failing or the strength shows signs of giving way under the prolonged strain.

*The local treatment* depends upon the depth of the burn, but the principle is in all cases alike; protect the part thoroughly from the air, prevent decomposition, and change the dressings as seldom as possible.

In those of the first degree, in which the area is limited, the ordinary domestic appliances, mashed potatoes, lead lotion, cold spirit and water, anything, in short, that is cooling and diminishes the hyperæmia, answers exceedingly well. Dry applications, such as flour, fuller's earth, etc., in many people cause a degree of irritation and of itching that is almost as painful. Flexible collodion or lead paint is very useful, especially on the body or where the skin is liable to friction from the clothes.

If blisters are present already they must be pricked, the fluid allowed to ooze quietly out, and the epidermis gently replaced; but when the case is seen sufficiently early, an attempt should be made to check their formation by limiting the amount of blood going to the part; this may often be managed by investing the affected area at once with boracic lint (wetted with cold boracic lotion if the sense of smarting is very severe), and then with many layers either of a similar material or of wood-wool or salicylic wool. A flannel bandage is placed over the whole with a fair amount of pressure, and the part is well raised. The dressing should be left on as long as possible, and when it is necessary to change it it should be allowed to float off in a bath. Carron oil (equal parts of lime water and olive oil) is a very favorite application, but the smell after it has been applied some little time is very nauseating; bicarbonate of soda (a saturated solution) is stated to relieve the pain more quickly than anything else, but though I have tried it in many cases, I cannot say that I have succeeded in persuading myself of its superiority. Zinc ointment answers well when the surface is of small extent, and the same may be said of vaseline, carbonate of lead ointment, resin ointment, and many others.

In burns of limited size but greater depth, the same principle must be adopted, but for these iodoform and corrosive sublimate can be used. If there appears to be a chance of drying up the sloughs and limiting the amount of exudation, the former is the better, freely sprinkling it all over, and then applying wood-wool over this. If, on the other hand, from its position, or from the length of time that has elapsed since the injury, and the amount of exudation that is present, this does not appear to be practicable, the part should be well irrigated with corrosive sublimate, or placed in a bath of it for a time and wrapped in boracic lint. In any case, whatever dressing is used for a burn, it should be left as long

sibly can be, and the greatest care is required when changing it not to disturb the newly-formed epidermis.

Finally, in some very severe cases amputation is required, but this should not be thought of until the shock is past, and preferably not until the line of demarcation is distinct. Occasionally it is performed at a later period, either because of prolonged suppuration or because the limb, although it has been saved, is merely an encumbrance.

After the sloughs have separated the suppurating surface left requires the same treatment as other wounds, the only difference is that the granulations have an extraordinary tendency to become pale, flabby, and exuberant. This, which is in great measure due to the distance from the base, and the defective contraction of the deeper layers, is best kept in check with nitrate of silver. Either a lotion of three grains to the ounce may be used for the whole surface, or, what answers better, the solid stick may be applied occasionally all round the margin. Grafting is usually necessary for the healing of large surfaces, but often it is very disappointing; rapid progress is made for a short time, and then suddenly the whole of the newly cicatrized area breaks down again. Every attempt, however, should be made to procure early cicatrization; contraction cannot be prevented altogether in a burn of the fourth degree (except by covering in the whole granulating surface with fresh or vivified grafts, as already described under cicatrices), but the longer the suppuration lasts, the greater the amount of dense, contracting tissue that is developed.

Mechanical appliances are often required, partly to keep the injured surfaces at rest, but chiefly to prevent contraction. Splints, extending apparatuses, elastic bands, etc., must be adapted to the special circumstances of each case, and no general rules can be laid down for them, except that their action must be continuous night and day. I have known three days' respite allow such a degree of deformity to take place, that the former position was never thoroughly regained.

[Burns of the fauces and upper air passages from the inhalation of steam should be treated by the atomization of dilute sulphuric ether, and its inhalation. The patient should be caused to breathe air charged with atomized dilute ether spray, until danger of œdema of the glottis shall have passed. When steam has been inhaled long enough to scald the tracheal lining the case is hopeless. Usually there is spasmodic closure when the steam touches the larynx, and the steam passes no further, but the editor once saw a case where the unfortunate patient had been pinned fast by timbers so that he was obliged to make several inhalations of the steam before he could escape. This man died an hour after reaching the

# CHAPTER IV.

## *MINOR SURGERY.*

### THE SURGEON.

[There have been many paraphrases, changes, and inte famous dictum of A. Cornelius Celsus, but, after all the comm been made upon it, the original still stands unimpaired by time. commentator, referring to Celsus' remark about the tremblin "a shakiness of the hand may be some bar to the success of an of a shaky mind is hopeless." It may be fairly presumed tha that any surgeon would be sound of mind and have a knowl He doubtless scarcely considered it necessary to assert in form surgeon should not be a lunatic or an imbecile.

Celsus said: "A surgeon ought to be young, or certainly v with a hand active, firm, nor ever trembling, and not less ready the right, with eyesight sharp and clear, intrepid in mind, comp he wish him whom he has received to be cured, and not to be m that he may hasten more than the thing requires or may cut less t but may do all things just as if no impression was received fro other."*

#### STERILIZATION OF THE HANDS.

The skin, by careful washing, may be made comparatively organisms, but it is less frequently done than is supposed, an utmost difficulty that the subungual spaces are freed from them in a report made to the writer in June, 1889, showed its difficu experiments on the subject, made at the Seaman's Retreat Hospi The observations extended over a period of three months, and t were instructed to use a nail-brush and scrub the hands with soap after which they immersed them in solution bichloride of me In some cases strong alcohol and ether was used. They then tions and dressed the wounds and ulcers in the wards. Scra from beneath their finger-nails at a time when they were maki the dressing, or just before an operation. "In all the examin Kinyoun, "in only two instances were the hands found to be s others bacteria were found." Repeated scrubbing and a most ca of the hands are therefore necessary to prevent the surgeon fr wound, and even then, in most cases, the hands and finger-ends ar aseptic, but the danger is probably reduced to a minimum.

#### CLOTHING.

The use of a gown that may be laundered, and thus kept cl the clothing of the operator, is also necessary for the prevention o tion of microbes into the wound.

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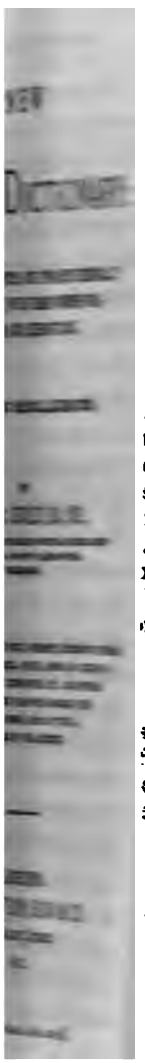
* The exact text is as follows: "Esse autem chirurgus debet adolescens, aut proprior; manu strenua, stabili, nec unquam intremiscente, eaque non minus sin promptus; acie oculorum acri, claraque; animo intrepidus, misericors sic ut sana accepit, non ut clamore ejus motus, vel magis quam res desiderat, properet vel mi est, secet; sed perinde faciat omnia ac si nullus ex vagitibus alterius affectus oria

### Instruments.



d to purchase cheap instruments. Procure the best quality, for better work while in use, but they retain their useful- tting instruments should have sharp edges when purchased, nd be well tempered. All joints should move easily, and they may be readily cleansed. The temper of a scalpel or y sharpening it on a fine oil-stone, a lithotrite by breaking rown sandstone the size of a filbert, and forceps by close es of hemostatic or pressure forceps should fit each other easily with the thumb and finger of the operator. It is y too much attention to the selection of instruments.

he scalpel blade may well be left to the judgment of the t a good instrument has a handle that is smooth, easily joined to the blade.

ld rather perfect himself in the use of the instruments that hastily construct one with only slight variation from a pre-

ld be carefully sterilized immediately before being used, and nd disinfected immediately after use. Sterilization may be n an ordinary sterilizer, or by steam, or by boiling in water er. Most disinfecting solutions spoil the polish and edge s when they are kept in them for any considerable time; it nd that in most cases boiling in water is the most convenient

n needles, and hypodermic needles, when needed in the be plunged in alcohol just before using, or passed through r lighted gas jet.

### The Patient.

t be prepared for operation by a general bath whenever ul cleansing, shaving, and disinfection of the surface of the d upon. If the operation is to be upon the abdomen, the viously emptied by a brisk saline cathartic, and a little the rectum well cleansed by injection of warm water, and of urine either naturally or through the catheter; female quired to use a vaginal douche, and all patients about to ration should have the urine examined.]

## THE ANÆSTHETIC.

### 1. LOCAL ANÆSTHESIA.

ice and salt or ether-spray causes numbness to the skin, but the surface; it cannot be kept up without the risk of slough- hawing is almost, if not quite, as severe.

rdrochlorate of cocaine sprayed or painted over a mucous surface or a round will ensure local anæsthesia for a quarter of an hour or more; but no use on unbroken skin or where the tissues are inflamed. The ordinary is gr. xx or ʒss (1.20 grammes or 15 grammes) to the ounce, and the should always be fresh, as it soon decomposes. It may also be employed mically, a grain or a grain and a half being injected at a time; but very ymptoms—syncope, delirium, unconsciousness, and even collapse—have own to follow. Whether this is due to the products of decomposition ug or to personal susceptibility is uncertain. Capillary oozing is always en cocaine is employed.

### 2. GENERAL ANÆSTHESIA.

Nitrous oxide gas, chloroform, ether, bichloride of methylene, and a mixture of equal parts of alcohol, ether, and chloroform (known as the A. C. E. mixture) are the chief agents used. The apparatus and the method vary in each case, but in all alike the clothing should be loosened, false teeth removed, and the patient placed in a suitable position (usually recumbent, with the head slightly raised and turned to one side). An anæsthetic should not be given for some hours after a meal; if there is a feeling of faintness or the pulse is weak, a small quantity of brandy may be given by the mouth or injected into the rectum.

*Nitrous oxide gas* is especially useful for short operations (the anæsthesia lasting about a minute) and as a preliminary to ether. It is practically free from danger, and is seldom attended with sickness or headache.

The gas passes from a reservoir through a face-piece, contrived to exclude air thoroughly. After a few inspirations the face becomes dusky and the breathing deeper; then toward the end of the minute the eyes grow prominent, the pupil dilate, the lips become blue, and the respiration stertorous; at this stage anæsthesia is complete; if the administration is continued convulsive movements begin. The insensibility may be prolonged without any unpleasant effect by giving a small quantity of ether with the gas after the first few breaths.

*Ether* is always given through an inhaler. In Clover's the same air is breathed over and over again, and the amount of vapor added is regulated by an index. In Ormsby's an ounce is poured upon a sponge at the beginning, and the proportion of fresh air varied.

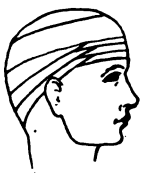
The vapor must be admitted very gradually at first, as it is so unpleasant that many patients can hardly tolerate it, and if possible preliminary anæsthesia should be induced with gas. As the amount is increased the face becomes congested, a period of excitement with violent struggling (especially in men accustomed to drink) follows, and then, comparatively suddenly, the muscles relax and the breathing becomes stertorous. If Clover's inhaler is used a breath of fresh air should be allowed every half-minute until anæsthesia is complete, then the interruptions should be more and more frequent until, when the administration has lasted some time, the inhaler is only applied occasionally.

As a general anæsthetic ether is much safer than chloroform, and unless contraindicated should always be used in preference. Unfortunately, it is more unpleasant, leaving a severe headache, and the smell hangs about for days. It is not suited to operations about the mouth, nose, or eyes, to operations upon the brain or large vessels, or to cases of bronchitis, empyema, phthisis, or extreme abdominal distention. Women and children take it very well; drunkards can scarcely be got under its influence, unless they are partially intoxicated already—then the transition from one stage to the other is very easy. Care must be taken not to bring it near a naked light nor near a Pacquelin cautery.

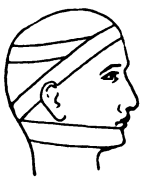
*Chloroform.*—All that is required is a drop-bottle and a fold of lint doubled. A few drops are sprinkled on first, then a few more, gradually increasing the quantity, and the lint is turned over so that the moistened surface may face the mouth; it must not touch it or the skin, for fear of causing blisters. The pulse and respiration (not the movements of the chest, but the actual influx and efflux of air) must be watched from the first. Except in children, a period of excitement nearly always precedes that of unconsciousness, and sometimes in men there is severe struggling; but unless the respiratory muscles remain rigidly contracted there is no need to suspend the administration. The pulse may be increased in frequency during the struggling stage and the pupil dilated; as it passes off the respiration becomes slow and deep, the pulse falls to its normal rate, and the pupil contracts, still retaining its power of reacting to light. Snoring, and the[1] the conjunctival reflex, are signs that the patient is fully anæsthetized. the administration may be suspended for a breath or two and then

# THE PRINCIPAL BANDAGES, I.

Recurrent of Head.

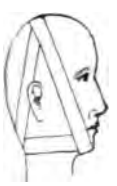


Oblique Bandage of Head.

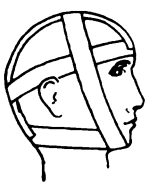


V-Bandage.

Occipito-Fa

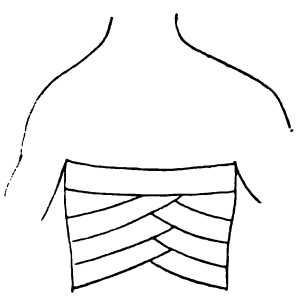


Barton's.

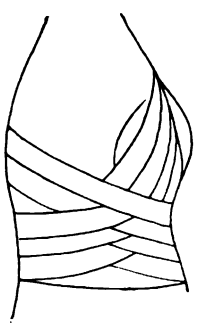


Gibson's.

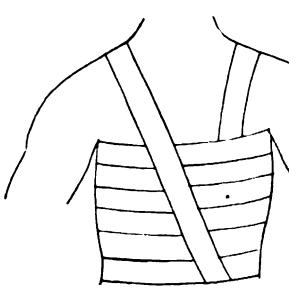
Crossed Bandage, Both Eyes.



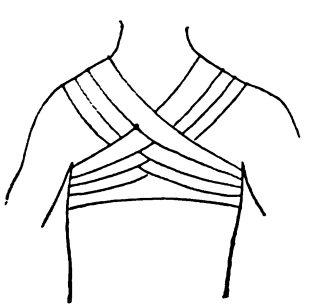
Chest Bandage.

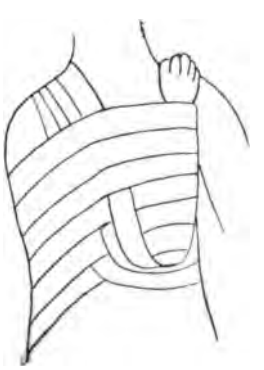


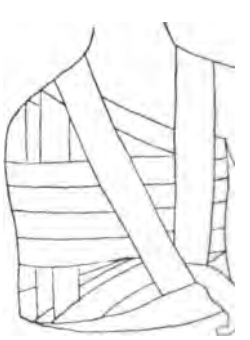
Compressor of Mamma.



Chest Bandage with Support







Velpeau.

Chloroform is preferable to ether for all operations about the mouth and nose (Junker's apparatus, in which air is driven through the liquid by means of a ball syringe, is especially suited to these), for operations upon the brain and eye, in infants and old people, in cases in which the breathing is embarrassed, and in midwifery. In all other conditions ether is more safe; it is true that deaths have occurred during its administration, but the proportion is not nearly so large as in the case of chloroform, and the patients have almost all been suffering from some grave internal disorder.

Chloroform acts both upon the heart and the respiratory centre. Syncope may occur with the first few breaths before the operation, or with the first incision (it has been suggested that in these cases it is really due to shock, the patient not being sufficiently anæsthetized). Spasm of the respiratory muscles may prove fatal during the struggling stage. Later, even after the administration is over, the respiration or the heart may stop, the latter usually giving the first indication, though the former is the first to cease altogether. For this reason it is absolutely essential to watch both the pulse and the breathing throughout.

An injection of morphia before the chloroform is given enables anæsthesia to be produced much more rapidly and without any struggling, but it very greatly increases the danger of syncope. Ether, on the other hand, diminishes the risk, and in many cases in which it cannot be given during the operation, it is advisable to anæsthetize the patient with it, and when the blood is well saturated substitute chloroform.

*The A. C. E. mixture* may be used instead of chloroform in many cases, but care must be taken that the mixture is fresh and that very small quantities are given at a time. The liquids evaporate with different degrees of rapidity, and if a large quantity is poured on to an inhaler at once, nearly the whole of one may come off before the others are appreciably affected.

*Bichloride of methylene* is best given with Junker's apparatus. Its composition is somewhat doubtful; probably it is only a mixture, and as it is affected by exposure to air, it should always be freshly opened. With women it succeeds fairly well, and there is very little tendency to sickness afterward; but it is difficult to secure a sufficient degree of anæsthesia in any patient accustomed to alcohol.

**Special Symptoms.**—*Struggling* and *excitement* are particularly severe in the case of ether. At the beginning they are due to the fearful sensation of choking caused by the vapor being too concentrated, and, making allowance for this, are under the patient's control. Later, they are involuntary. Epileptiform convulsions may occur, but the chief danger is the sudden inhalation of an excessive amount of vapor. A considerable degree of excitement is sometimes met with during the recovery from ether, especially if the anæsthesia has not been of long duration.

*Vomiting* is almost sure to occur if the stomach is full, and may prove serious. It may happen at the beginning, but it usually takes place later, or during recovery. Pallor of the face and lips, failure of the pulse, and retching precede it, and the administration should always be stopped until the stomach is emptied. No food should be allowed for some hours after an anæsthetic, merely a few small fragments of ice, if the thirst is great, and for the first twenty-four hours everything should be cold. If vomiting persists, bismuth and morphia may be given and a mustard plaster applied to the epigastrium; but usually it is better to leave the stomach altogether alone and feed the patient by means of enemata. I have known minim doses of vinum antimoniale every quarter of an hour succeed in a case that seemed likely to prove serious.

*Dyspnœa* may arise from respiratory spasm during the struggling, but a much more common cause is the falling back of the tongue and the collapse of the upper aperture of the larynx. When this is slight it causes a peculiar stertor, which can be relieved by pressing the point of the chin forward and upward, or, if this does not succeed, by seizing the tongue with a broad pair of forceps and drawing it

well out of the mouth. The condition is easily relieved if the cause is noticed, but as the thorax continues to move naturally there is great danger of overlooking the fact that no air is entering.

*Heart-failure* is an accident peculiar to chloroform. As already mentioned, it may occur with the first few breaths, or during and even after the administration; and it may be accompanied or not by failure of respiration. At the first suspicion of weakening of the pulse the anæsthetic should be stopped and every endeavor made to clear the lungs of the vapor that fills them; the tongue should be drawn forward; if the breathing is not deep and thorough artificial respiration should be commenced, and if there is the least impediment to the entry of air tracheotomy should be performed. A subcutaneous injection of ether or brandy may be of some service, and inversion of the patient, so that the head receives a full supply of blood, is undoubtedly of use; but neither galvanism nor nitrite of amyl has been proved to be of any practical benefit.

[*Suppression of urine* may be one of the disagreeable after-effects of the administration of ether, in persons with fatty kidneys. One fatal case of this nature fell under the editor's observation. Chloroform in such a case is the safer anæsthetic.]

## Bandaging.

[The operation being finished, the parts well cleansed and dried, the application of suitable bandages are imperatively required, for the double purpose of assisting to maintain the wounded surfaces in apposition and to prevent infection. The wound should be sprinkled with iodoform or other desiccating powder, a thick pad of iodoform gauze laid over it, and next to that a smooth layer of absorbent cotton, over which should be laid rubber protective, or a bandage of several thicknesses of sterilized gauze. Sterilized gauze has latterly superseded the old cotton roller in the majority of cases.

**After Treatment.**—After the patient shall have been properly bandaged, measures should be taken to prevent shock. These consist in the application of external heat by means of a bag, filled with hot water, sterilized flannel cloths well heated and applied to the abdomen and extremities. If necessary to bring on reaction, brandy may be given by the hypodermatic syringe, in teaspoonful doses, according to the urgency of the case. Careful regulation of the diet is also necessary when the patient begins to take food. The surgeon should give explicit directions about the length of time the patient should remain in bed. These will necessarily vary, according to the nature of the case, and the position which the patient assumes in bed is not a matter of indifference, but, on the contrary, should be made the subject of the surgeon's directions. These points may seem trivial, but their neglect may entail serious consequences to the patient.]

# PART III.

# DISEASES AND INJURIES OF SPECIAL STRUCTURES.

## CHAPTER I.

### *SURGICAL DISEASES OF THE SKIN.*

#### LUPUS. (Tuberculosis of the Skin.)

A very chronic, destructive, and scar-leaving form of inflammation of skin and mucous membranes, commencing in the corium proper. Leaving apart the form known as lupus erythematosus, we may say that common lupus begins almost invariably at an early period of life, often during childhood, and cases starting after the age of thirty are very exceptional. Its subjects may be, at the time of the outbreak, in otherwise good health; it is, however, asserted that they are often the offspring of phthisical parents, and in some cases they may themselves develop later tubercular disease. Koch has proved that the bacillus tuberculosis is sparingly present in nodules of lupus.

The tendency of a patch of lupus is to spread at its edges as well as to invade the deeper parts and the adjoining mucous membranes; spontaneous cicatrization may occur, but generally the disease lasts indefinitely unless treated. The early recognition and prompt treatment of lupus is most important in preventing permanent disfigurement.

The first stage of lupus consists in the formation of small yellowish-brown or pink nodules, of softer consistence than the healthy skin. These are found to consist of small-celled infiltration of the corium, with scattered giant-cells (in which the bacillus of tuberculosis may be occasionally detected). The nodules have a semi-translucent or "apple-jelly" aspect, the next stage being the breaking down of the centre and the formation of a pustule, succeeded by superficial ulceration or desquamation. There is often an extensive scabbing or eczematous condition over a lupus patch, especially if irritated by exposure to wind, cold or wet weather, etc. Finally, the lupus nodule may cicatrize, the scar formed being usually prominent, dense, and often of a pinkish hue. But complete spontaneous subsidence of a lupus patch is rare; whilst one part is breaking down or cicatrizing, fresh nodules are forming in the neighboring skin, or perhaps at some distance from the original site, and in a single patch all the stages of apple-jelly-like growth, pustules, eczematous condition, ulceration, and scarring may often be observed. If situated near a mucous membrane (*e. g.*, of the mouth or nose), lupus tends to invade it, forming large, soft granulations, but not often presenting the typical yellowish-pink or brown nodules seen on the skin. The lips, gums, palate, and even the pharynx and aperture of the larynx may be invaded, the septum and cartilages of the nose [illegible], or great deformity (ectropion and destruction of the lids) produced by [illegible] the conjunctiva.

[illegible] of lupus seen occasionally on various parts of the [illegible]lood-infection from a single original patch. Lupus

rarely begins as a primary growth in the mucous membranes, but occasionally it does so; for example, perforating the septum nasi by a solitary ulcer. The lymphatic glands are not infrequently secondarily enlarged, and may break down into the ordinary strumous glandular abscess. So-called lupus of the genitals (particularly of the vulva and vagina) is nearly always due either to syphilis or epithelioma. One character is constant to lupus, wherever situated—a very slow course, rebellious to treatment, and tending to relapse again and again at intervals of months or years. There is also a special liability to the development of epithelioma in an old lupus patch, the cancer being then of a most virulent and destructive type. In connection with this tendency it is worthy of note that epithelial downgrowths may frequently be seen in sections of recent lupus patches, and, in fact, it is difficult to tell such sections from those of true epithelioma. When lupus affects a part of the body covered with thick epithelium (*e. g.*, the feet), warty growth is a prominent feature, the soft nodules being entirely absent. What is known as verruca necrogenica, a condition seen on the hands of those who have to handle dead bodies, is probably a form of lupus, microscopical examination showing the same structure, though there is not the same tendency to advance and destroy the tissues as in the ordinary form of the disease.

**Diagnosis.**—Bearing in mind the origin at an early age, the inveterate ten-

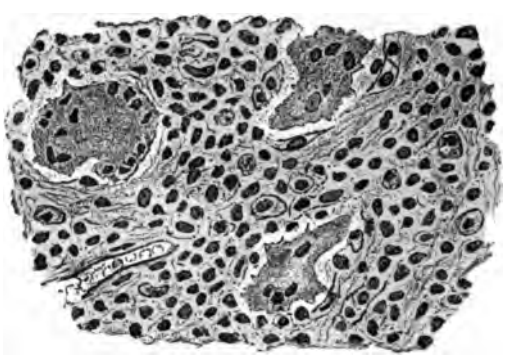


FIG. 35.—Section from Lupus of the Nose (× 350 diam.) Giant-cells are seen with cell-infiltration.

dency to persist and to spread, the scarring left by the disease, and the usual presence of the apple-jelly-like nodules at some part of the patch, the student will have little difficulty in recognizing most cases of lupus. The deposit of lupoid growth may sometimes be very small as compared with the scab-formation and scaling of epidermis, and thus simulate an eczema, but the latter disease never leaves scars. The greatest difficulty arising in diagnosticating certain cases of tertiary syphilis (whether acquired or inherited) from lupus, and the term syphilitic lupus is a convenient, but not perhaps accurate, one for these cases; the following points will generally lead to a correct diagnosis:—

1. The patches of "syphilitic lupus" tend to have a crescentic or horse-shoe outline, and are more commonly widely separated from each other than those of true lupus.

2. The tubercles or nodules are of a browner-red color and firmer consistence than those of lupus. "Apple-jelly" deposit is never seen in syphilis.

3. Syphilitic lupus, when due to the acquired disease, commonly starts later in life (*e. g.*, from thirty to fifty) than true lupus, though, of course, there are often exceptions. When due to inherited syphilis, the disease tends to be rapidly destructive, and is often accompanied by necrosis of the adjoining bones (*e. g.*, palate and nasal bones). In fact, the latter form of the disease is of the nature of phagedæna, and requires prompt local and constitutional treatment to arrest

its progress (cauterization with acid nitrate of mercury and the administration of iodide of potassium and mercury). Inherited syphilitic lupus will eat away in a week or two as much tissue as ordinary lupus will take months or years in destroying.

4. The presence of other symptoms of syphilis, the polymorphism of the skin-disease, the history of acquired or inherited taint, will be of value in assisting the diagnosis. For instance, Dr. Hutchinson treated a young man who had been supposed to be affected with ordinary lupus of the mouth, destroying within a short time most of the soft palate. The history of an attack of interstitial keratitis (from which there still remained nebulæ) pointed to the syphilitic origin of the disease, a diagnosis confirmed by the rapid destruction of parts which had occurred and the great improvement which ensued under specific treatment.

Whenever the diagnosis between syphilis and lupus cannot be made, a careful trial of mercury and iodide of potassium should be carried out for a few weeks, remembering, however, that both these may occasionally fail in spite of the disease being syphilitic, local treatment by cauterization and the use of iodoform being then required.

It may be here stated that there is not the slightest evidence of true lupus depending upon remote syphilitic taint, as has been asserted by some writers.

**Treatment.**—Whilst constitutional measures—cod-liver oil, good diet, and all means likely to improve the general health—should not be neglected, local treatment is always needed to effect a cure. This consists in destroying the soft lupus nodules by scraping, cauterization, or the action of certain chemical destructives.

1. *Scraping.*—This is best performed (nearly always under an anæsthetic) with Volckmann's sharp spoons, various sizes of which are employed. The spoon is used vigorously wherever there is any sign of the lupus nodules, and particularly at the margin of a patch; it has no effect upon normal skin or scar tissue. After scraping, the fine-pointed actual cautery is often applied to each excavation made, or pure carbolic acid may be cautiously used with a small brush. The sores are subsequently dressed with vaseline, boracic acid ointment, etc., and if all the lupus-tissue has been destroyed they heal fairly rapidly (of course, leaving scars).

2. *Destruction by Chemicals.*—The use of pure carbolic acid as an adjunct to scraping has been alluded to; it is supposed that the pain of the application is diminished by subsequent free dusting over with powdered carbonate of soda. Acid nitrate of mercury may be applied with success to very small lupus nodules, best on a sharpened piece of wood, which is thrust right into them. Chromic acid fused on a probe is recommended by Jameson for the same purpose. Both methods cause a certain amount of pain, but this is insignificant compared with that produced by chloride of zinc and potassa fusa, two caustics formerly recommended but now deservedly abandoned. Strong lactic and salicylic acids have lately come into use; both have a marked preference for the lowly-organized lupus-tissue over the healthy skin. Salicylic acid is used in the form of a plaster spread on muslin, the plaster containing from 20 to 50 per cent. of the acid mixed with creasote (which deadens the pain). The application is renewed twice a day until the lupus nodules have broken down and suppurated freely, when some simple ointment is applied. This salicylic-creasote plaster was devised by Unna, and is known by his name; in commencing the treatment the weaker strength should always be used. Whichever method be adopted, great patience is requisite in the treatment, which usually requires to be repeated several times at intervals before a cure can be effected, and it must be admitted that in some cases (especially if the mucous membranes are much involved) none can be hoped for. But the tendency of lupus to cause irretrievable deformity, as well as the danger of epithelioma supervening, will encourage the surgeon to persevere in one or other of the methods of treatment recommended.

## LUPUS ERYTHEMATOSUS.

This disease, being much rarer and less amenable to surgical treatment, requires only brief notice here. Like lupus vulgaris, its pathology consists in small-celled deposits in the corium (though it is doubtful if giant-cells or bacilli are ever found), and it has a similar very chronic course. But in lupus erythematosus abnormal vascularity of the patches is much more marked, there is hardly any destructive tendency, symmetry is constant from the first, the disease begins later in life than does common lupus, and the local treatment of the latter is here not suitable. Further, it may be noticed that lupus erythematosus has a special predilection for certain parts, namely, the nose, cheeks, ears, and backs of the hands; and the sebaceous glands are especially involved in the disease as well as the smaller blood-vessels. There is the same tendency to leave scars as in lupus vulgaris, but they are less conspicuous. Not unfrequently the patches of lupus erythematosus assume the bat's-wing shape—the body being represented on the nose, the wings on the two cheeks, while smaller patches exist inside each concha of the ears. They present a reddish or brown color, a thickened edge, and dilated capillaries or small veins, and dry eczematous spots are to be noticed at various parts of the patch.

The disease is more common in women than in men, and especially in those liable to chronic dyspepsia and flushing of the face, or with feeble circulation, or prone to chilblains. It seems to be occasionally started by an attack of facial erysipelas.

**Treatment.**—This is very unsatisfactory, the long-continued use of weak tar ointment and lotion or of the oleate of mercury ointment being, perhaps, the best. Pure carbolic acid may be applied to the most prominent parts, or the fine-pointed actual cautery if the vascularity is very pronounced.

## BOILS AND CARBUNCLES.

There is no reason for separating these two forms of cutaneous and subcutaneous sloughing abscess, since both may be set up by the same general cause, the only real difference being that a furuncular abscess or boil discharges its contents by a single opening, a carbuncle by several (which often later coalesce). And several other purulent affections of the skin are of the nature of boils—for instance, the common styes of the eyelids, a superficial form of whitlow, and the large pustules which, occurring usually in parts with thick skin, are known as ecthyma. There is reason to believe that all these furuncular abscesses are due to the presence of a micrococcus, and their discharge is certainly contagious (*i. e.*, it may produce similar abscesses in the neighborhood of the primary ones).

A variety of debilitating causes may lead to an outbreak of boils—deficient or improper food, the hydropathic treatment, etc.—and they are not infrequently met with during convalescence from a severe fever (especially typhoid). Training for athletic purposes, if the change of life is marked and sudden, often produces them; and a too vegetarian diet may have the same result. Work in the dissecting or *post-mortem* room occasionally causes their development, and the connection between diabetes mellitus and carbuncle was long ago pointed out and, indeed, overestimated. Certain parts of the body—speaking generally, those in which there is a dense or coarse subcutaneous layer—are especially liable to the development of boils and carbuncles. The back of the neck and trunk and the buttocks are the favorite sites, though the external meatus of the ear, the hands, and feet are not uncommonly affected. The features of both are too well known to need description, but it may be noted that throbbing pain is almost a constant symptom until the pus and broken-down cellular tissue are given an exit. The extensive separation of sodden epithelium over and around a carbuncle is also noteworthy. Sometimes boils abort—that is, never pass beyond the inflammatory stage—and this is most likely to occur if they are protected from external irritation by the

use of thick plaster as soon as they are recognized. The friction of a collar may localize a boil on the neck, that of a hard seat in rowing may produce one on the buttock, etc.

**Diagnosis.**—It is occasionally a question whether a superficial abscess with a central slough is of carbuncular or gummatous nature, but the rapid course of a carbuncle and the severe pain that attends it will usually suffice to decide the matter without going into the history as to previous syphilis. The ulcer left after the slough has come away is ragged and somewhat undermined at the edge.

**Treatment.**—If seen early, a boil should be protected by thick plaster (a small central hole being made), and any friction of the clothes should be guarded against. A saline aperient should be given, and such dietetic or tonic treatment adopted as is indicated by the individual case. Painting tincture of iodine over the inflamed spot and the injection into it of a few drops of strong carbolic acid solution are both said to cause resolution in some cases, but generally it is advisable to hasten suppuration by warm fomentations, the most cleanly being an antiseptic poultice (carbolic acid lotion—1 in 40—on lint, or boracic lint applied moist under oiled silk). These antiseptic fomentations are much better than the linseed poultices, which have a decided tendency to bring out a crop of smaller furuncles around the primary one. If there is very great pain, or if the suppurative process appears to be spreading, an incision should be made, the relief which follows the outlet of pus being very great. The old free crucial incisions are pretty much abandoned. When all slough has separated, a very good dressing is the Ung. Resinæ.

Sulphide of calcium (gr. j daily in pills) and yeast are both said to have some mysterious effect in preventing or checking the development of boils, styes, etc., but the evidence is not very satisfactory. Lately it has been recommended to treat carbuncles, if seen fairly early, by making an incision and scraping and squeezing out the purulent and necrotic centre, subsequently dressing the sore with iodoform or carbolic solution. This method, though painful, appears to hasten the healing and perhaps to prevent the spread of the carbuncle.

## ULCERS.

Any sore left by the destruction (gradual or sudden) of the superficial parts of skin or mucous membrane is an ulcer, the process either starting from the surface and extending to the deeper parts, or *vice versâ*. An ulcer, for instance, may begin as a small pustule, or in the centre of a patch of eczema, or it may arise in the sloughing out of a gumma or carbuncle. In deciding the nature of an ulcer we have to consider its site, shape, depth, the character of its edge, the surrounding skin, and its base or floor. It must not be supposed, however, that each variety of ulcer has its own peculiar features, and that we can always tell the cause by careful inspection of the sore alone (though this will in some cases suffice). For instance, some tertiary syphilitic ulcers may closely simulate rodent or epitheliomatous sores, or they may be practically indistinguishable from ulceration due to lupus, or even that resulting from a carbuncle.

Certain terms are used in describing ulcers, independent of their causation, of which the following are the chief.

A *chronic* ulcer (which is seen so commonly in the lower third of the leg) is characterized by its indolent process, hard, congested edge, and unhealthy base, *i. e.*, unless healing under treatment no well-formed granulations are present. Such an ulcer may take on, from neglect and the irritation of decomposition, the *sloughing* process. The term *phagedænic* is applied if the ulcer steadily spreads, but without the formation of large sloughs, and this feature is almost invariably due to syphilis.

An *eczematous* ulcer is one in which the main features of the disease are those of eczema, the ulcer being comparatively superficial, but usually intensely irritable. It is surrounded by pustules and "weeping" desquamating skin.

The terms *congested* and *inflammatory* ulcers will be readily understood; th name *varicose* ulcer is inappropriate, since it is not the ulcer itself, but the tissu around, that present the varicose veins.

Since the life or death of the tissues depends chiefly upon a constant supp of healthy blood and its free circulation, with the removal of waste products b the lymphatics, it is obvious how large a share circulatory defects are likely to hav in the production and perpetuation of ulcers. Impeded arterial supply, as aft ligature of a main artery of a limb, or in senile gangrene, and venous obstructio of all degrees, afford examples. In old-standing infantile paralysis the circulatio of the affected limb becomes very feeble, and most intractable ulcers are liable t form. Passive congestion from prolonged standing is a very frequent excitin cause of ulcers of the legs, especially in and after middle life.

Vitiated conditions of the blood, as in syphilis, scurvy, etc., are also commo causes, and simple anæmia may help in producing ulceration. The loss of vitalit of the tissues that comes from old age must be mentioned. Paralysis of a sensor nerve may be followed by ulcers in the affected area, partly, no doubt, due to th action of irritants, such as long-continued pressure, partly, perhaps, to a "troph influence."

The common forms of ulcer met with in practice are the following:—

### 1. Syphilitic Ulcers.

Omitting the primary chancres, these are of two chief varieties—that due t the breaking-down of a gumma, and the serpiginous tubercular form. No part o the body is exempt, though certain regions are especially liable, such as the upp third of the leg, the neighborhood of the knee joint, over the sternum and th skull.

In the case of the gummatous ulcer there will be the history of a (frequentl painless) lump forming, the skin over it becoming congested and breaking dow and of the exit of a slough which is aptly compared to sodden wash-leather. Th sore left is rounded, with inflamed margin and sharply cut or punched-out borde and the characteristic ashy-gray slough is often seen in the cavity of the ulce Not infrequently the slough has been greater than the amount of skin destroye *i. e.*, the edge will be undermined, but hardly ever to the same extent as a tru scrofulous or tuberculous sore. After healing has resulted a thin white supple sc is usually formed, around which may be a brown pigmented area, but this la feature is often absent, except in the lower limb, and is there not peculiar t syphilis.

The rapidity with which destruction takes place in tertiary syphilitic ulcers very marked, and serves to distinguish them from any other forms, and equall definite is their speedy healing under appropriate treatment, but if neglected the may persist for long and become indistinguishable (except, perhaps, by their sit from the ordinary chronic inflammatory ulcer.

The treatment consists in the administration of iodide of potassium (of whic iodide of sodium and spirits of ammonia are useful adjuncts) or of mercury wit the iodide, and in the local use of iodoform or black-wash. Rest of the pa affected, tonics given internally, sea-air, and the avoidance of stimulants may be a required in obstinate cases. In prescribing iodoform as a dressing it must b borne in mind that the drug, though a powerful agent in promoting healing, liable to irritate the surrounding skin, setting up severe erythema or eczem Using it as a weak ointment (5 to 10 grains to the ounce) or as a powder dilute with starch, etc., is often quite as effectual and less likely to irritate than emplo

assume the crescentic or horse-shoe outline, and steadily to advance in one direction whilst healing in the part first affected. I have known such an ulcer to start at the ankle and (completely encircling the limb) travel up to the middle of the thigh before its further progress was stopped by treatment. It had never been more than an inch in width, and left the skin behind it quite supple. The question of diagnosis of this form from true lupus has already been alluded to. In its treatment the same applies as to gummatous ulcers, but it may be mentioned that oleate of mercury ointment (5, 10, or 15 per cent.) is often a very useful local application. In neglected or inveterate cases it is sometimes necessary to scrape the growth, or to cauterize it with the acid nitrate of mercury or actual cautery before healing can be obtained. If once thoroughly healed it shows no tendency to recur, unlike true lupus.

### 2. Tubercular Ulcers.

Apart from the ulceration due to lupus, we have to consider the strumous form resulting from tubercular abscesses of the cutaneous or subcutaneous tissues. Although most common in early life, they may originate in elderly subjects (senile struma) and are in the latter case of very unfavorable prognosis.

Glandular enlargement and abscesses are common complications, and pulmonary phthisis is, of course, not infrequent,

The appearance of a tubercular ulcer is very characteristic; dull, purplish congestion of the edge, extensive undermining of the skin, thin, oily discharge, and pale, flabby granulations at the base usually leave no doubt as to the diagnosis. When they heal a thick scar is generally formed, often with small cutaneous "tags" along it.

The treatment consists in destroying the wall of the ulcer and sinus by scraping or cauterization, and subsequently dressing the cavity with iodoform. Boracic fomentations, etc., cod-liver oil, residence at the seaside or in the country, good food, etc., are most important aids to recovery.

### 3. Chronic Inflammatory Ulcer of the Leg.

The chronic inflammatory ulcer of the leg is seen especially amongst the poorer classes. The lower third of the leg toward the inner side is its usual site, and it often starts in some injury. The vitality of the tissues is previously lowered as a rule, however, by prolonged congestion from standing; both varicose veins and eczema are its frequent forerunners. The patient often states that the ulcer commenced as a small pustule, or that intense irritation at one spot led him to produce an abrasion by scratching. A weak heart or chronic bronchitis may favor the obstruction to the return of blood, the presence of the ulcer increases the congestion, and thus a vicious circle is set up.

The ulcer usually causes much pain and discomfort, though cases differ much in this respect; not only the edge becomes callous, but the floor also, and if it has existed long the immediately subjacent bone undergoes condensing ostitis, to which may be partially due the aching pain felt. Steadily increasing, the ulcer may encircle the limb and spread upward over a large area, and at any time, from neglect of cleanliness, etc., it may take on sloughing action. The older the patient, as a rule, the less does the chance of healing become, though some very intractable ulcers are met with in young women in whom no constitutional cause can be assigned.

Treatment in very inveterate cases must be merely palliative, and a variety of applications (such as the Ung. Zinci, the Ung. Acidi Boracici, weak carbolic lotions) may be tried in turn until one is found to suit the individual case. Amputation of the limb is occasionally necessary, but should rarely be urged, since the low vitality of the tissues above often greatly impairs the result, and the risk to life in all elderly subjects is not inconsiderable.

A large number of these ulcers can, however, be cured, though, unfortunately, there is great likelihood of the scars breaking down again. The following measures will be found useful:—

*a.* Rest and elevation of the limb are most important and should be carried out as far as possible.

*b.* Bandaging the leg from the foot to the knee, either with the ordinary linen bandage or with an elastic (Martin's) bandage. The latter cannot be used unless the ulcer is almost healed, and by its keeping in moisture sometimes causes too great discomfort to be borne. An elastic stocking will often be of use in such cases. Carefully applied strapping above and below the ulcer is also beneficial.

*c.* To clean a foul ulcer and to promote granulation there are few dressings more valuable than boracic fomentations, made by wetting boracic lint and applying one or two thicknesses of it under gutta-percha tissue. The dressing must be changed once or twice daily, according to the amount of discharge.

*d.* The Ung. Resinæ, Ung. Iodoform, Ung. Plumbi Subacetatis, and the two previously mentioned are of use according to the special indication, that is, whether stimulating or soothing applications are required.

*e.* Skin-grafting and sponge-grafting are valuable if the granulations have been got into a healthy condition and the patient can be kept in bed for a few weeks. In using the skin-grafts they should be cut into minute pieces and only the epithelial layer employed.

*f.* In a large number of cases tonics do good, the bowels should be kept regularly open, alcoholic excess forbidden, and if varicose veins are present, it is often helpful to limit the amount of fluids taken, so far as is judicious.

There is one drug which has a very beneficial action upon inveterate ulceration, especially in old people, namely, opium, the administration of which is said also to check the progress of phagedænic or sloughing action.

*g.* Blistering the edge of a callous ulcer was strongly recommended by Syme, and is occasionally useful. Some surgeons have advocated incising both base and floor of such ulcers, with a view to start a fresh granulating process.

### 4. Traumatic Ulcers.

As already noted, a considerable proportion of the previous class of ulcers originate in some injury, often a very slight one, but we have to note some due to severe contusion of the skin of healthy individuals—really direct traumatic gangrene. This is especially likely to occur in regions where the skin lies immediately over a bone—for instance, the tibia or patella. An antiseptic poultice followed by some simple ointment is the best treatment, skin-grafting being advisable if the ulcer is large. The limb should be carefully kept at rest during treatment if the ulcer is situated over a joint.

In this class come the ulcers of artificial production, which may at first give rise to difficulty in diagnosis. A hysterical or idle girl, for the sake of exciting sympathy or notice, applies some strong chemical irritant to the skin, using great cleverness sometimes in concealing the cause of the ulcer which results, and in preventing it from healing. In one case I knew of a young lady who had applied sulphuric acid to the front of the left elbow, causing a deep ulcer, in which, for some time, the brachial artery lay exposed. The unusual situation of these factitious ulcers, their rapid formation, and the character of the patient will usually excite suspicion as to their true origin.

### 5. Malignant Ulcers.

*Rodent Ulcer, Epithelioma, Fungating Sarcomata, Scirrhous Ulcers.*—These need not be described here, as they come under the head of tumors. It may be mentioned, however, that epithelioma may supervene in the course of any in-

tractable ulcer which has lasted for some years, and that a particularly malignant form is liable to develop in old lupus patches, the patients being usually past middle life.

## NON-MALIGNANT GROWTHS OF THE SKIN.

### NÆVI.

The essential feature of all angeiomata or nævi depends upon the presence of convoluted vessels closely packed together, commonly small veins and capillaries, but occasionally arteries. One form consists in a widespread area of small vessels, such as is seen on the face—the "port-wine stain;" another (the true venous nævus) is situated more deeply and composed of much larger veins.

The terms cutaneous and subcutaneous are used with reference to nævi, though no sharp line of distinction can be drawn. They may be met with on any part of the body, the head and neck being their most frequent site, and it is common to find more than one on the same subject. If sections be made of an ordinary cutaneous nævus, it is curious to notice how slightly the lumen of the vessels shows in comparison with the thickness of the cellular wall. There is no doubt that after birth a nævus frequently increases in size; on the other hand, with advancing years they may shrivel in part or entirely disappear. Sometimes they ulcerate—a curious fact considering their high vascularity. "Port-wine" nævi usually remain unchanged throughout life if untreated, and are by far the most resistant to treatment.

A *mole* is a congenital local hypertrophy of the skin, pigmented, and with usually abundant growth of hair on it. Moles are of little importance if seated on a part of the body naturally concealed by the dress, and even on the face are, if small, sometimes considered ornamental. But there is an undoubted tendency for them in advanced life to become the seat of melanotic sarcoma, and for this reason their excision should be advised. However, sometimes they are so large that removal by operation would leave an awkward wound, and here a plastic operation may be called for. They can also be destroyed by repeated cauterization, but the process is not so satisfactory as excision.

One most curious growth allied to a mole is occasionally seen on the scalp—lobulated and softish projections of the skin with deep furrows between them, so arranged as strongly to suggest the brain convolutions.

The treatment of nævi consists principally in one or other of the following measures:—

1. The application at several parts of the nævus of the actual cautery (fine-point). This is most effective and leaves but little scar. It is well to proceed cautiously, and to do little at the first operation rather than too much.

2. If subcutaneous and venous, the cautery point may be thrust in several directions through the nævus, introducing it through only one opening in the skin.

3. Excision is suitable for small nævi, and is by some considered better than cauterization.

4. Electrolysis has of late been extensively tried, two needles being used as the poles, and both pushed into the growth at a short distance from each other. They should be introduced at several points. The method may be successful in leaving imperceptible scars, but it is an uncertain one and needs to be repeated several times, as a rule, before much improvement occurs. It is especially adapted for nævi of the face.

Such measures as vaccination over the nævus, the application of ethylate of sodium, and subcutaneous ligature are occasionally useful, especially the latter—but this has the drawback of possible sloughing of the skin.

### WARTS.—[*Papilloma.*]

[There are four varieties of the papillomata, viz.: wart, mucous tubercle, condyloma, urethral caruncle].

Warts are chiefly met with about the hands of young adults or children, and are composed of hypertrophied papillæ covered with epithelium. Each papilla contains a central vascular loop, and, especially if scratched and irritated, is liable to bleed. They may occur in great numbers on the hands (especially the dorsum) and forearms, and may undergo simultaneous and rapid atrophy. In their treatment it is important for the patient to abstain from "picking" and irritating them; perhaps the best local application is the glacial acetic acid, which, applied repeatedly with a small brush or point of wood, will soon cause them to shrivel and drop off. Nitric acid is more painful in its action and less certain; nitrate of silver is useless as a rule.

In elderly subjects single warty growths are met with, the tongue, lips, and scalp being often affected. They are much more serious than those of early life, from their liability to go on to epithelioma. This is especially the case with warts of the tongue and lips, and on this account it is usually advisable to excise them.

The venereal form of wart (*condyloma*) is seen about the vulva, the prepuce, glans penis, and scrotum, in cases of gonorrhœa or vaginitis. They are especially prone to develop if there is phimosis and retention of the discharge, to the irritation of which they are due. They may attain a very large size and have very vascular bases. Sometimes a neglected condyloma becomes wart-like, but true acuminate or pointed warts have no real relation with syphilis. In treating them the gonorrhœa should be cured, circumcision performed if there is phimosis, a drying powder applied, and strict cleanliness used. If they show no tendency to shrivel under this treatment they should be excised with scissors, and the bleeding checked if necessary with the actual cautery at a dull red heat.

Salicylic acid is a powerful agent in softening warty and hard epithelial growths of the skin, and is of much use in treating corns on the feet. It may be applied in the form of plaster which is renewed daily, or as a cream made with glycerine. As soon as the softening process is complete the part should be soaked in warm water, and the overgrown epithelium pared off with a knife. Of course, injurious pressure should be removed so far as is practicable.

### [CLAVUS.—*Corn.*

A *corn* is a callosity of the epidermis caused by pressure with friction whereby the skin becomes thickened and painful. The external surface of the corn is broad, its substance narrowing as it projects inward, becomes conical, and much pain is produced. This conical point of the hardened epithelial cells is termed the "core" or "eye" of the corn, and it acts as a foreign body by being driven upon the true skin. "Soft" corns are sometimes produced between the toes. They do not differ anatomically from the other variety, but by reason of being constantly bathed in the natural moisture of the part derived from the sweat glands are softened.

The *treatment* consists in removing the pressure and paring off the thickened epidermis. Great relief will usually be experienced by painting the corn with the following application:—

℞. Ext. cannabis. indicæ fl., . . . grammes 1
Acidi salicylici, . . . . . " 8
Collodii, . . . . . q. s. ad. . " 50 M.

The collodion film thus produced may be removed together with a considerable layer of epidermis, without pain, at the expiration of thirty-six to forty-eight hours. Another thick coat should then be applied and, after about the same time,

[HORNS.—*Cornu Cutaneum, Dermato-keras.*

Horns are outgrowths of the epithelial surface which may occur on almost any portion of the cutaneous surface, but are most frequent on the scalp and face. These growths resemble a clubbed toe-nail or finger-nail, and are sometimes grooved.*

Horns are in general easily removed, but are occasionally found firmly attached to the periosteum. They should be extirpated as soon as recognized.]

## DISEASES OF THE NAILS.

Like the hairs, the nails are liable to be invaded by the fungus of tinea tonsurans and of favus, both mycelium and spores being occasionally found in their substance. In association with eczema of the hands or feet the nails may become affected, the inflammation then chiefly involving their roots and causing secondary changes in the nutrition of the nails themselves. With severe general psoriasis, too, there is sometimes great thickening of the nail-substance, which becomes brittle and opaque, but in the slighter cases the nails usually escape. A form of dry, chronic onychitis is also met with, in which no general skin disease exists. A very troublesome disease to treat; arsenic given internally being the most likely measure to do good, combined with frequent soaking the affected finger-ends in a tar lotion.

FIG. 36.—Chronic Onychia.

Syphilitic onychitis usually occurs during the secondary stage; the nail-ends become brittle and irregular, this form occurring both in the acquired and inherited disease. Sometimes the nail-root is especially involved, becoming narrowed as though it were pinched laterally (see "Illustrations of Clin. Surgery," vol. 2, plate 81). Shedding of the affected nails may then occur, new, healthy nails ultimately taking their place.

A peculiar and troublesome form of ulceration, creeping round the nail, and occasionally resulting in its complete detachment, is met with, especially in those who have to do with *post-mortem* work, surgical dressings, etc. It is, as a rule, decidedly painful, although it is not necessary in most cases to remove the nail for its cure, yet the finger should, if possible, be kept protected by an antiseptic dressing under oiled silk. Powdered boracic acid, or a powder containing equal parts of iodoform, tannic acid, and oxide of zinc, will be found of service as a local application.

The exfoliation of a nail as the result of a crush is too well known to need description, but it may be noted that frequently the process is very gradual and painless, and in such cases there is no need to hasten it by premature avulsion.

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[* I removed a horn from the third finger of a female child at the Rush Medical College Clinic, in 1892. D. J. Hamilton mentions a case of a boy where the whole skin was covered with them from the crown of the head to the sole of the foot. Dr. Porcher, of Charleston, S. C., reported a case of a horn seven inches in length and two and three-quarter inches in diameter growing from the forehead of a negress aged about fifty-two. Dr. A. L. Sands, of Cold Spring, N. Y., removed a horn from the back of the head of a white woman aged fifty. This horn was six and a quarter inches long and three inches in circumference. It was of sixteen years' growth. Dr. Pausa, of Naples, in 1836, removed one six inches in length from the parietal scalp. Mr. Dalby, in 1847 (*Lancet*), removed a horn six inches in length from the head of a female patient. Dr. Souberbiele, in 1851 (*Am. Jour. Med. Sci.*), reported the extirpation of a horn eight to nine inches long, from the forehead of a woman aged eighty-two. The most curious of reported cases, however, is that of Paul Rodriques of Mexico, (*Lancet*, 1825), who was the subject of an enormous horn measuring fourteen inches at the base. This horn had three branches of which the central was largest. It was curved and descended several inches below the ear, thence turned forward on the cheek.]

A new nail is probably more likely to grow if the exfoliation is left wholly to nature.

A slight injury is sometimes the primary cause of what is known as *onychia maligna*, an affection practically confined to children. The nail becomes loosened, altered in shape and much discolored, the finger-end swells up and discharges a fetid pus from below and around the nail. So severe may the inflammation be in onychia maligna, if neglected, that the terminal phalanx is liable to necrose, and there is little or no tendency to spontaneous cure. This may be due to the fact that its subjects are generally delicate or "strumous" children. With proper treatment recovery is usually very rapid. The diseased nail should be removed with forceps, and a dressing of iodoform, or of the liquor arsenicalis (one drachm to the ounce) applied. If these measures fail, a single application of the acid nitrate of mercury, or nitric acid, will usually suffice to stop the ulceration. Tonics, especially iron, are generally useful adjuncts to the local treatment.

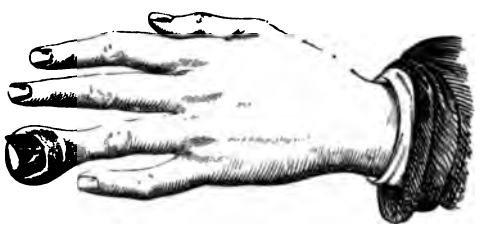

FIG. 37.—Onychia Maligna.

*Ingrowing toe-nail* is nearly always met with at the outer side of the great toe and may be produced by the pressure of tight boots, or by cutting the nail too deeply away at its angles. Unhealthy granulations form around and bury the edge of the nail, and much discomfort is thereby produced. The treatment in the early stage consists in the removal of pressure from the toe and applying a few shreds of cotton-wool, charged with the astringent powder already mentioned, under the edge of the nail with a probe. Cleanliness and the daily repetition of this process will sometimes suffice. If it does not succeed the central portion should be scraped thin with a piece of glass and some thin lead-foil inserted under the angle. The nail itself should never be removed if it can possibly be avoided; when it grows again it is even more distorted than it was before. The granulations, if very exuberant, may be cut away, and iodoform dressing applied; but removal of the whole of the side of the fleshy part of the toe, though strongly recommended by some, is unnecessarily severe.

[The removal of the entire nail with its matrix is occasionally necessary, and although clubbed nail may result, yet the great relief furnished by the operation is a sufficient justification for its performance. Touching the site of the matrix with the red hot iron, after extirpation, may prevent the nail from being repro

# CHAPTER II.

## *INJURIES AND DISEASES OF BLOOD-VESSELS.*

## SECTION I.—INJURIES.

Blood-vessels may be contused or bruised; ruptured, either partially or com pletely; wounded, or divided. When the external coat remains intact, as in lig ature of arteries, and in some cases of contusion, and when, owing to the way i which a vessel is torn across, the coats are twisted together, no blood is lost. I every other case the immediate and most prominent symptom is hemorrhage, eithe externally or into the substance of the tissues.

Hemorrhage may be capillary (coming not so much from the capillaries them selves as from vessels too small to secure individually), venous or arterial.

### Local Symptoms.

**Capillary** hemorrhage is never serious except in patients with the hemo rhagic diathesis. It is sometimes tolerably abundant from the walls of an absces the sudden relief of pressure causing the delicate capillaries in the granulatio tissue to give way; and after the application of Esmarch's bandage, when a lim has been kept anæmic throughout the course of a prolonged operation, it may b so considerable as to make the operator doubt whether there has been any re advantage to the patient; but as a rule it stops at once on exposure to the ai especially if the part is raised at the same time, or with gentle compression. Ic cold water may be poured over the exposed surface if this fails; or better stil water at the temperature of 130° F., about as hot as can be borne with the hanc Carbolic lotion should not be used, as this tends to make the clot disintegrate agai In many cases, especially after amputations in which the bloodless method has bee adopted, it is better to close the wound and trust to firm bandaging and elevatio than to keep the patient waiting on the operating table; but due provision mu be made for drainage, or there may be a considerable degree of traumatic feve

**Venous** hemorrhage is recognized by the dark color of the blood and th steady character of its flow. Unless there is considerable pressure upon the cardia side (as when a ligature is tied round the limb, and occasionally in hemorrhoid the stream is always continuous, never in jets. Usually it comes from the lower c distal end, but when a large trunk is wounded, or a varicose vein, in which th valves are incompetent, gives way, the rush from the cardiac side may be so gre as to prove fatal within a very few minutes. The slightest pressure, applied to th right spot, or merely raising the part so that it is not dependent, is sufficient t stop the flow at once; but many instances are recorded in which, for want of th simple precaution, this accident has proved fatal.

**Arterial** hemorrhage may be *primary*, at the time of the injury; *recurren* within twenty-four hours; or *secondary*, from any time after this until the woun in the vessel is healed. The distinction between the two last is of considerab importance. Recurrent hemorrhage is due to failure in the temporary closure o an artery; the ligature by which it is secured has slipped, or pressure has failed, o as the heart recovers from the shock and beats more vigorously the clot has bee washed out, and the contracted condition of the vessel's wall unfolded again b the internal pressure. Secondary hemorrhage, on the other hand, points to a failu in the measures by which permanent closure is effected. The wall of the artery too badly nourished, from atheroma or from suppuration round it, for the exud

tion to become organized; or the ligature has been tied so tightly that it cuts through before the protecting barrier of lymph is sufficiently strong to resist; or the presence of a sequestrum or of some other foreign substance has caused ulceration without repair. The symptoms, too, are different; the former is rarely sudden and is seldom serious unless the wound is loosely covered over with a thick layer of absorbent material; then sometimes it escapes notice until a very large amount has been lost and the patient's face is blanched. The latter, though it rarely occurs without giving a warning (some slight stain on the dressings the day before), may be of the most serious description, especially as it nearly always comes from the largest vessels, in which the pressure is very high.

In primary hemorrhage from a wounded artery the blood is bright red, and comes in distinct jets, which, even in vessels smaller than the radial at the wrist, may shoot three or four feet. Occasionally, however, when the patient is anæsthetized with nitrous oxide, or is partially asphyxiated from excess of carbonic acid, the color is darker, approaching that of venous blood; and when the wounded vessel is concealed at the bottom of some deep cavity, the flow may apparently be continuous. Recurrent hemorrhage, when the opening is exposed, does not differ in any material way; but sometimes in secondary bleeding after ligature of an artery in its continuity the blood wells up slowly in a continuous stream, coming from the distal end only, and having lost its force in the collateral vessels.

When the blood, instead of escaping externally on the surface of a wound, pours into the tissues or one of the natural cavities of the body, the local symptoms are regulated by the size of the vessel, the pressure of the stream, and the readiness with which surrounding structures yield. Hemorrhage from small vessels is rarely important unless the number that give way is very great, as in some of the dorsal or lumbar hæmatomata. There is local swelling, which usually disappears again after a time, although it occasionally ends in organization or suppuration. If, however, the vessel is an artery of any size, and the tension is not checked, the tissues may become inflamed, or suppuration may set in, or the part may even become gangrenous from the collateral circulation being cut off.

Hemorrhage into the pleural or peritoneal spaces, internal hemorrhage in the strict sense of the term, often causes no local symptoms. In other cases a certain degree of dullness can be made out in the dependent parts, and an alteration in the level of the fluid in different positions of the body, especially as blood when extravasated into serous sacs coagulates slowly; but although this, when it does occur, is distinctive, its absence proves nothing.

### Constitutional Symptoms.

The rapidity with which the blood is lost is almost as important as the quantity. When it pours out under high pressure from some great artery, the face becomes pale and livid at once; the lips are white, the extremities cold, the pulse low and quivering, and the respiration hurried and shallow, interrupted every now and then by yawns or deep sighs. The voice is lost, there are noises in the ears, the eyesight fails, nausea comes on, and the arms are tossed vaguely and wildly about over the head. If, on the other hand, the loss is more gradual, the face and lips become peculiarly transparent, like wax, the pulse is small and fluttering, the breathing quick and very irregular in depth, giddiness and faintness come on with the least exertion, and if the loss continues, dropsy makes its appearance owing to the impoverished condition of the blood. In such a state the slightest further drain may prove rapidly fatal. Sudden hemorrhage produces a much more marked effect than oozing to the same amount continued over several hours, and the consequences at the extremes of life are much more serious than in adult age. Even when the immediate effect is not fatal, recovery is often incomplete, the patient never really regaining strength, but dying, perhaps some months later,

### Natural Arrest of Hemorrhage.

The natural means by which hemorrhage is stayed are partly constitutional, partly local.

1. **Constitutional.**—The force of the heart-beat diminishes in proportion to the amount of blood that is lost; in syncope it can scarcely be felt. Meanwhile, before the strength returns, the blood has time to coagulate, and with good fortune this may prevent further loss. In the case of large arteries, however, it is seldom effectual; as the fainting passes off, the heart regains its power, and the bleeding begins again. Sometimes temporary cessation and recurrence alternate more than once before death ensues. It is said that the blood which is lost toward the end coagulates more readily than that which comes at the beginning, and this may help a little.

2. **Local.**—Owing to the structure of the internal and middle coats of an artery, the inner tube contracts as soon as it is divided and shrinks to such an extent that only a small orifice is left. This is due, in part at least, to its muscular fibres. At the same time, owing to its great elasticity, the two ends retract and become separated from each other by a considerable distance, the inner part again shrinking very much more than the outer. If the vessel is put on the stretch first, so as to bring this elasticity into full play, as when, for instance, a limb is torn off, the orifice may contract and retract to such an extent that no blood at all is lost. As a rule, however, a certain amount pours out, and this flowing over the torn and irregular surface formed by the broken ends of the internal and middle coats and the interior of the sheath, coagulates and fills all the space round and inside the ruptured end with what is known as the external clot.

Generally, but by no means invariably, an internal clot forms as well. The blood as it whirls round in the closed ends forms a conical-shaped coagulum, the base of which rests upon the ruptured coats, to which it is firmly adherent, while the apex, lying loose in the interior, reaches as high as the next largest branch. This, when it is present, must act to some extent as a buffer, saving the outer clot from the shock, but it is not essential to permanent repair.

If, when the heart recovers, this combined barrier is sufficiently strong to resist the impact of the blood, the permanent changes begin. The vasa vasorum, the minute vessels in the sheath, and those which lie in the tissues round, dilate; more plasma pours through their walls; the leucocytes pour out more rapidly and in larger numbers; the torn ends of the fibres swell up and disappear; and gradually the external clot and the base of the internal one are invaded from all sides by the cellular exudation, and the fibrin and red blood-corpuscles are gradually replaced. The endothelium of the vessel itself near the torn end disappears as such and fuses with the growing lymph; probably, except in the largest trunks, under the stimulus of injury it regains some of its lost power and begins active growth again. Possibly some of the leucocytes in the still circulating blood, where it whirls round and round the conical clot, help as well, gradually filling up the narrow cleft that lies between it and the wall. In any case, by the third day a button of firm, newly-formed lymph seals the end of the vessel, lying between the edges of the curved-in coats, to which it is firmly adherent. After a time this lymph becomes vascular; new vessels form, some coming from the vasa vasorum in the thickened and softened coats, others springing from the cavity of the vessel above, many from the sheath as well; and organization rapidly follows. The final change is the shrinking of the newly-formed tissue, the gradual obliteration of many of its vessels, and the contraction of the artery above the seat of division up to the origin of its next large branch.

When an artery is divided in its continuity the changes are the same; but repair is much less perfect at the distal than the proximal end, and secondary hemorrhage is much more common from the former than from the latter. In some cases, the two ends separate completely and retain no connection with each

other; more frequently a fibrous band is left between them; and occasionally a vessel is developed, and enlarged by slow degrees until it re-establishes a direct communication.

Whether hemorrhage ceases spontaneously or not depends partly upon the size of the vessel, partly upon the character and direction of the wound. If the artery is torn in two, even the axillary at the shoulder may close completely without the loss of a drop of blood. In a case of clean division, as with a knife, the result is more doubtful; an artery the size of the temporal (provided it is perfectly healthy) usually causes no trouble; the brachial or the posterior tibial in the upper part of its course retracts sufficiently for a time; but hemorrhage is almost certain to commence again as soon as the heart regains its power. In the femoral this almost always happens. A transverse wound which does not completely sever the vessel never stops bleeding of itself unless it is of the most minute dimensions; the elasticity of the coats holds the wound open, and many of the worst cases of hemorrhage are traceable to the incomplete division of some comparatively small branch.

Arteries that are either rigid from atheroma, or are contained in rigid canals, whether made of bone, fibrous tissue, or the dense cicatricial tissue met with after old suppurating wounds (such as septic compound fractures), naturally, if they are divided, cannot retract, and consequently bleed furiously.

### Treatment of Hemorrhage.

The first thing always is to secure the bleeding point wherever it may be, and whether it is an artery or a vein. The subsequent treatment turns entirely upon whether this can be done or not.

#### 1. *If the Bleeding Point has been Secured.*

When the loss of blood is sudden, every care must be taken to keep the heart and brain as well supplied as possible. Any quick movement, particularly raising the head, might at any moment bring on fatal syncope. The patient should be laid perfectly flat, without a pillow, and with all the clothing loosened round the chest; it may not be possible to remove it. The limbs should be raised, and they may be even lightly bandaged. Hot bottles and warmed blankets should be packed all around, and every attempt made to maintain the temperature. If the heart is failing, hypodermic injections of brandy or ether may be tried; in other cases, very small quantities of hot brandy and water, not more than half a teaspoonful at a time, may be given at frequent intervals by the mouth. Rectal injections of warm water are sometimes of great service, absorption taking place with very great rapidity, owing to the diminution of fluid in the vessels. Finally, if none of these measures suffice to maintain the action of the heart, intravenous transfusion with human blood or with saline solution may be tried. The blood of other animals, in spite of the fact that it is said to have succeeded, must never be used; the plasma of the one destroys the blood-corpuscles of the other, and, even if it does not cause general clotting, makes the destruction worse; and milk does not appear to possess any advantage. Intra-peritoneal transfusion has succeeded in animals, but I am not aware of its having been tried in men.

Where the loss of blood is gradual the same method may be adopted; but instead of relying upon the temporary effect of stimulants careful dieting is required with easily digested food, and after a time very mild preparations of iron in small doses. If the loss has been severe, cases of this kind require watching for many weeks.

#### 2. *If the Bleeding Point Cannot be Secured.*

In the internal hemorrhage this is, of course, often impossible; and even when it is external it is a rule, in primary bleeding, not to interfere further, if the

loss has ceased when the wound is exposed. The injured part may be covered with iodoform under gentle pressure, and must be watched night and day; but it should not be explored.

In cases of this kind great care is required to prevent collapse on the one hand and avoid reaction on the other. The wound in the vessel is closed chiefly by coagulum, and the main hope lies in this not being washed away when the heart regains its power. Accordingly, stimulants should never be given unless the case is desperate. Absolute rest, warmth, and small fragments of ice from time to time, to relieve thirst, are all that is possible at first. Later, if other conditions admit of it, small doses of opium (combined with gallic and sulphuric acids) are very beneficial; but the diet must be kept low; the patient must not be allowed to raise a finger; and even talking must be prohibited until there is a reasonable chance of the wound in the vessel having become sealed. The actual onset of secondary hemorrhage can nearly always be traced to coughing, laughing, straining at stool, or some other trivial exertion.

## INJURIES OF ARTERIES.

### RUPTURE.

Rupture of an artery may be complete or incomplete, and may occur with or without an external wound. It is said to be complete when all the coats are divided at any one spot, not necessarily in their whole circumference.

#### 1. *Incomplete Rupture.*

The coats of an artery may be torn by a contusion, if the vessel is superficial, or is caught against the bone (the common femoral, for instance); or they may give way from over-extension, especially at the knee joint, and in the reduction of old dislocations. In the operation of ligature, partial rupture is often produced deliberately, with the view of effecting more certain closure.

Owing to their anatomical structure, the internal and middle coats usually give way without the external (Fig. 28). If tied tightly with a narrow ligature they are cut as cleanly as if divided with a knife, and then they retract some little distance, but do not curl in far. On the other hand, in contusions, and when an artery is torn from over-extension, they not unfrequently twist up together, and completely close the lumen. In disease, when an artery is rigid and calcareous, or is softened and thinned, partial rupture is not uncommon; but the behavior of the coats of the vessel is entirely different, and usually the rupture sooner or later becomes complete.

FIG. 38.—Laceration of the Internal Coats of an Artery from Injury, with a Coagulum (*B*).

Partial rupture of an artery may end in its occlusion; in imperfect repair with the formation of a traumatic aneurysm; or in complete rupture.

In the first of these three the clot, as already described, forms on and beyond the torn ends of the internal and middle coats, and gradually becomes replaced by vascular organizing lymph; the artery is obliterated, although occasionally a small vessel forms subsequently in the band that joins the ends; and the consequences depend upon the collateral circulation. If this is good, no ill result ensues; if the walls of the vessels generally are rigid, and the heart's action weak, or if, owing to extravasation, dilatation of the neighboring branches is impossible, gangrene follows.

In the second, organization and repair begin, but the process is not completed; and under the influence of the

blood-pressure the still unbroken external coat, the blood-clot that lines it, and the tissues outside it stretch more and more until they form the wall of a sac, in other words, a *traumatic aneurysm.* This is distinguished from the ordinary form (which likewise can usually be traced back to some violent strain) by the fact that the wall of the artery for the rest of its course is perfectly healthy.

In the third case the remaining part of the wall gives way, either at once or later, after partial repair and the formation of an aneurysmal sac; the rupture becomes complete.

### 2. *Complete Rupture.*

When there is an external wound the hemorrhage is usually profuse, and if the vessel is large, continues until either syncope sets in or the result proves fatal. Sometimes, however, when the artery has been violently pulled out, as when a limb is torn off, the internal and middle coats curl up so tightly that the blood does not escape.

When there is no external wound the blood spreads far and wide in the limb, wherever the resistance is least, forming what is known as an *arterial hæmatoma.* It is most common in connection with fractures, and the reduction of old dislocations of the humerus. If the rent is a large one, and the tissues round the vessel are loose and yielding, as in the case of the axillary and popliteal, the loss of blood may be so profuse as to cause syncope; an immense, ill-defined swelling forms within a few moments; the pain is extreme; the limb beyond becomes swollen, œdematous, and cold; and the pulse in the distal vessels ceases completely. Pulsation can rarely be detected, except perhaps over a limited area and, as a rule, there is no bruit, or if there is, it is not conducted along the vessel as in the case of an aneurysm. When, on the other hand, the opening is a small one, or the tissues immediately around it resist and restrain the outflow, the symptoms are much more vague, and resemble at first those of traumatic aneurysm then, perhaps quite suddenly and after several days, the barrier gives way, and the full effect is produced at once.

The diagnosis of an arterial hæmatoma from an acute and deep abscess is sometimes very difficult, as there may be a considerable degree of inflammation round it. If a thrill, or bruit, or pulsation can be detected, it is clear at once but in any case of doubt, a puncture with a grooved needle is perfectly safe Occasionally it is mistaken for a rapidly-growing malignant tumor.

**Treatment.**—Simple *occlusion* of a large vessel as a direct result of injury is very rare; the small ones may be more commonly affected, but then the symptoms are too vague to be recognized. If it is noticed that the limb is cold and has lost sensibility and power, and that the pulse cannot be felt in the parts below without there being any swelling or extravasation to account for it, the diagnosis is very probable. The limb should be raised, wrapped thoroughly in cotton-wool without being bandaged, and carefully watched. If gangrene sets in, it will probably be of the dry variety, and if the access of moisture can be prevented a line of demarcation will gradually form without any constitutional disturbance. One or two toes only may be lost, even when the popliteal is blocked.

*Traumatic aneurysm* usually makes its appearance some time after the accident, as a soft, pulsating swelling in the course of one of the arteries. It can readily be emptied by pressure upon the trunk above, and fills itself again in the characteristic manner. As the vessel from which it springs is perfectly healthy, it may be dealt with in almost any manner that is suited to the locality and size of the artery. When, for example, it occurs in the anterior tibial in connection with fracture of the leg (the most common form) it usually gets well of itself while the fracture is becoming firm.

*An arterial hæmatoma* is much more serious, whether it occurs at once or is secondary to the formation of an aneurysm. If the extravasation has ceased to extend and the circulation in the limb below is good, gentle pressure may be tried partly to support the vessel, partly to assist absorption. If, on the other hand, the

swelling continues to increase there is no alternative, an attempt must be made to find the seat of injury and tie the artery above and below. The vessel must be compressed on the cardiac side, a free incision made into the extravasation, all the clots turned out, and the seat of injury exposed. Then a ligature must be placed round it above and below, at a sufficient distance to ensure the wall being healthy, and if it is thought advisable the trunk may be completely divided in between. A director or a stout probe passed through the opening into the vessel renders its isolation from the blood-stained and thickened tissues round much more easy. In this way I secured the external iliac and the common femoral for a rupture of the intermediate portion of the artery, which only became complete four weeks after the receipt of the injury that caused it. The presence of gangrene leaves no choice; amputation, if practicable, must be performed without delay.

### Wounds of Arteries.

The effects of complete transverse division of an artery in a wound have been already described. The internal and middle coats contract and retract; if the vessel is a very large one death ensues, in spite of this, at once. If not so large, syncope occurs; the heart beats more feebly, and an external, and then an internal, coagulum forms. Sometimes this is not enough; when the heart regains its power, bleeding recommences and soon proves fatal; in most instances, fortunately, and probably in all when the artery is as small as the temporal and the walls are healthy, the combined resistance is sufficient; lymph is poured out, and organization and permanent repair set in.

Incomplete division, on the other hand, unless the wound is a minute puncture, does not admit of repair unaided. A transverse cut is held widely open by the elasticity of the wall, and a longitudinal one gapes with every pulse-beat. Probably most of the cases of persistently recurring hemorrhage from small and medium-sized vessels are really due to the fact that the wall is only partially cut through; complete division, allowing the coats to retract all round, is, in many cases, an effectual cure

Arterial hemorrhage can only be mistaken when the blood wells up from the bottom of some deep cavity; or when, some days after the complete division of an artery, repair fails at the distal end. When this occurs the flow is continuous rather than intermittent, but its steady persistence and rapidity rarely leave the question in doubt for long.

**Treatment.**—The treatment of a wounded artery depends upon the size and position of the vessel, and upon whether the bleeding has already ceased or is still going on. In the former case steps must be taken to prevent recurrence; in the latter, as the natural method of arrest is insufficient, provision must be made to assist and supplement it.

*Temporary Measures.*—Hemorrhage must be stopped at once by pressure upon the bleeding point or upon the artery above. If the spot is the right one the amount of force that is required is exceedingly small. The subclavian can be controlled with the thumb pressing it down upon the first rib, the operator standing behind and somewhat over the patient; the brachial is even easier, especially in the middle of the arm where it lies in the angle on the inner side of the biceps. In the lower limb very little is required for the femoral as it passes from beneath Poupart's ligament, and digital compression can easily be maintained for half an hour and more, if the operator stands well above the patient so that his arms are almost straight. In Hunter's canal a firm grasp can control it against the femur from the inner side, but it cannot be kept up for long. The tibials are only superficial for a short distance above the ankle; in the upper part of the leg they are out of reach.

Firm flexion at the knee or elbow diminishes the force of the stream below very considerably, and may, if carried far enough, stop it altogether; but it is

In thin people and in children the abdominal aorta can be felt beating just above and a little to the left of the umbilicus, and here it can be compressed with ease. If, however, there is much fat, or the abdomen is prominent, it is much more difficult, and sometimes it can hardly be managed even with Lister's tourniquet.

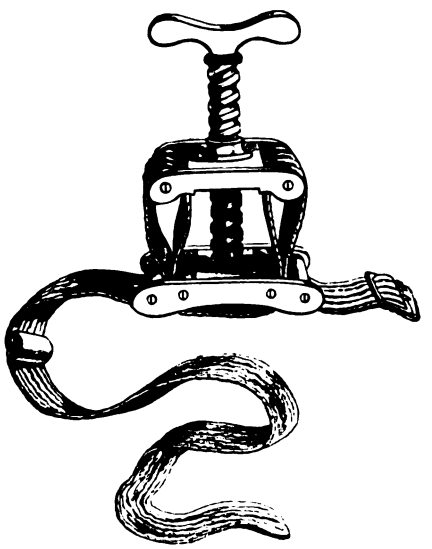

FIG. 39.—Petit's Tourniquet.

*Tourniquets* are required when compression has to be maintained for any length of time; the simplest is *Esmarch's*, a piece of ¾-inch rubber tubing twelve or eighteen inches long, with a hook at each end. No anatomical knowledge is required. It is simply stretched out and wound around the limb above the bleeding point, or in the case of the hip and shoulder arranged in a figure-of-eight with one loop in the axilla or groin, as the case may be, and the other held to prevent slipping. A small wooden block to fit over the artery is very useful for the femoral at Poupart's ligament; it must be grooved on the upper surface to receive the band and padded on the lower, so that the whole pressure may fall upon the right spot.

There are, however, several disadvantages in connection with this. Nerves have been paralyzed by it, the prolonged compression and anæmia leading to

FIG. 40.—Petit's Tourniquet Applied to the Brachial.

FIG. 41.—The Same Applied to the Femoral.

physiological interruption. It encourages sloughing, especially if applied to check primary hemorrhage before amputation. The amount of oozing tha

follows when it is removed is so great that, although it absolutely prevents loss of blood from large vessels (and so is of undoubted service when nothing better is at hand), it is sometimes questionable whether in the case of a large wound the real saving has been very considerable; and it is intensely painful. Accidents of this kind are much more likely to happen when the limb has been previously rendered bloodless by the use of Esmarch's bandage, but they have been known to follow the application of a single rubber band.*

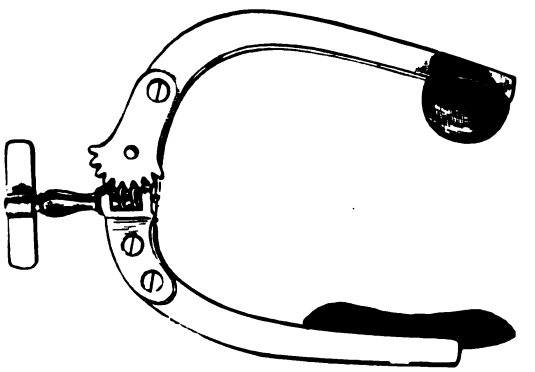

FIG. 42.—Signoroni's Tourniquet.

Other kinds of tourniquets are only of use for special arteries. *Petit's* (Fig. 39) can be employed for most below the axilla and the groin. The pad, or preferably a roller about an inch and a half thick, is placed over the main vessel, the band is buckled close to the limb and the screw turned quickly, so as to compress the artery as soon as the veins and avoid passive congestion. A bandage around the limb is advantageous, as it prevents the skin being dragged. *Signoroni's* (Fig. 42) is horse-shoe shaped with a pad at each end (one for pressure upon the artery, the other to give sufficient resistance) and a screw and ratchet in the middle, so that the arc can be opened or closed at will. It is chiefly of use for the femoral in the groin, the larger pad being placed well beneath the tuberosity of the ischium. *Lister's* is made in the same way, but is of larger size and intended for the abdominal aorta. It should be placed upon the patient's right side, so that the vessel does not slip off the fourth lumbar vertebra, and should only be screwed up at the last moment, and with just enough force to interrupt the circulation.

*Davy's* rectal lever is a smooth, round bar of wood which is introduced through the anus into the end of the sigmoid flexure, so as to cross the common iliac in the angle between the lumbar spine and the psoas. By raising the handle the vessel is readily compressed. It may be used for the right side as well as for the left, and to control the branches of the internal as well as those of the external iliac; but great care has to be taken in introducing it, owing to the folds that are always present in the rectum. Perforation has been produced by it.

In cases of emergency a tourniquet can be improvised at once out of a handkerchief tied round the limb and twisted tightly. A stone should be placed inside it to make a firm pad over the vessel.

In wounds of the neck and in some parts of the trunk pressure with the finger on the bleeding point is the only temporary expedient of any good.

Wherever it is possible and the bleeding is not too serious, the patient should be removed at once to a convenient couch or bed. This must be done with the greatest care, the patient not being allowed to raise himself or make the least effort. Then, as soon as a good light has been obtained, the clothing must be gently separated or cut over the seat of injury, all blood-stained bandages and wraps removed, and the wound thoroughly inspected.

If the bleeding has ceased and does not return when the tourniquet is removed, the parts around may be quietly sponged and the wound itself dusted with iodoform, but the clot must on no account be detached. Careful watch must be kept for recurrent hemorrhage; a tourniquet may be placed on the limb ready to be screwed up at any instant. It is quite possible that when the heart regains its power, slight serous oozing will begin, and that very soon the coagulum will be

[* Many of these objections may be removed by placing four or five layers of gauze between the tubing and the skin, before tightening.]

washed away and the bleeding recommence; but until this happens any interference is unjustifiable. The best hope lies in absolute rest; if the clot is not disturbed organization may set in and gradually render the wound secure.

*Permanent Measures.*—If the bleeding persists, it must be stopped either by making use of some general remedy, such as heat, cold, or pressure; or by isolating and securing the vessel. Which of these plans is to be adopted depends upon the size and position of the bleeding point.

*Cold.*—Simple exposure to the air is sufficient to stop oozing from small vessels; if a greater effect is desired, ice-cold water or ice itself may be used. It acts upon the muscular coat and consequently is of especial use when many small arteries have been divided.

*Heat.*—Hot water (temp. 125° F. to 140° F., practically as hot as can be borne with the hand) acts better than cold on tissues that have been exposed to the air for some time (as in prolonged operations) or rendered bloodless by Esmarch's bandage. The *actual cautery* is used where the structures are soft and spongy and the oozing persists without its being possible to define any one spot. It should be black or at the most dull red; if it is brighter the tissues are burnt away and stick to the iron, so that when it is removed the bleeding begins again. When applied to an artery an eschar is formed, generally of all the coats, which curl up together, and an internal coagulum is deposited almost at once upon the injured tissues. The process is not instantaneous; if the vessel is of any size the point of the cautery must be held in steady contact with it for some moments, or the closure is incomplete. Secondary hemorrhage is more common after this than after torsion or ligature.

*Pressure* is of much wider application. General oozing that does not yield at once to cold or heat may be effectually checked by bringing the surfaces firmly together. It is by far the most convenient method for arteries of the scalp; the occipital or temporal may be secured at once with a bandage; indeed, care is required in applying a capelline one not to interrupt the circulation unnecessarily. In punctured wounds involving the deep palmar arch there is practically no alternative, and nearly always, even when arteries are secured in other ways, pressure is employed to assist, partly for the sake of the support it gives, partly because of the control it exercises over the circulation.

If the bleeding point is on one of the limbs and the hemorrhage is definitely arterial, the pressure must be applied systematically, and with a clear idea as to what is required. A well-padded, accurately-fitting splint is essential to offer a certain degree of resistance and to keep the part at rest. The whole of the limb beyond, and for some distance upon the cardiac side, must be carefully packed with cotton-wool and bandaged. A graduated compress made of many layers of lint, placed one upon the other and cut so as to form a cone, must be adjusted upon the exact spot; the apex piece may advantageously be made of cork; and then one or two small strips of strapping must be carried over the base to fix it securely in its proper place. Further, a small longitudinal roll of lint may be adjusted over the course of the main artery above the wound and secured in the same way. Then, finally, separate bandages are to be placed over each of the compresses, so that the pressure upon one can be varied or removed without affecting the other. The limb should be raised after the bandages are in position, and the joint above flexed, so as still further to check the flow; but very careful watching is required for fear of gangrene. If no trouble of this kind threatens, and if the hemorrhage does not return, the dressing of the wound should be left undisturbed as long as possible; and when it is detached the lowest piece of the compress should be left untouched. When the tissues have healed beneath, and the wound in the vessel is sound, it will come away of itself; and if the part is well dusted with iodoform and kept dry, there is no fear of any extensive suppuration occurring.

The plan may be adopted for punctured wounds of the deep palmar or plantar arch. The amount of pressure is not so important as the exactness

of its application; very little really is required if it is on the right spot; if it is on the wrong one, either the bleeding continues or it causes sloughing.

Pressure is also needed sometimes for other arteries which have been injured in parts that are peculiarly inaccessible. The internal pudic, for example, or some abnormal branch, may be wounded in lateral lithotomy in such a way that it cannot be secured; or one of the intercostals may be punctured by a stab. A dilatable india-rubber bag may be used for these. It must be introduced into the wounded part, inflated by means of a tube, and then secured with a clip or stopcock. If this fails, digital compression for twenty-four hours may be tried, or some form of acupressure; but it must always be recollected that often in these cases the vessel is only punctured, and that complete division may bring the bleeding to an end at once.

If the artery lies in a bony canal (the descending palatine, for example, which has been wounded in the operation for cleft palate) hemorrhage can only be stopped by plugging, using either a rounded splinter of wood, or, if the vessel is on the face of a stump, some wax or soap.

*Elevation* causes marked contraction of the arteries of a limb, and is very useful as an adjunct, but of itself it has little or no power, except over the bleeding from veins and capillaries.

It is still an open question, when there is distinct arterial bleeding from some deep-punctured wound, how far it is justifiable to trust to pressure. The alterna-

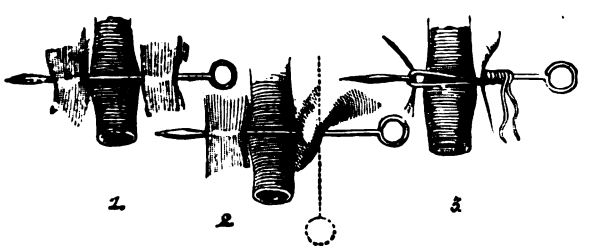

FIG. 43.—Different Modes of Applying Acupressure.

tive, enlarging the opening and trying to find the bleeding point, which may quite possibly lie on the other side of the limb (the posterior tibial, for example, has been wounded from the front), is often an operation of very great difficulty, and sometimes, from the circumstances of the case, simply impossible. Even when there is every assistance at hand, the attempt has often failed, and certainly, unless all the conditions for a prolonged search are favorable, pressure is advisable, at least as a temporary measure. The progress of the case will generally determine whether further steps should be taken or not.

*Acupressure* is of great use in certain special cases. Occasionally, for example, an artery is imbedded in such dense cicatricial tissues that it can neither retract and close nor be isolated for ligature. I have on two occasions secured the posterior tibial in this way when everything else had failed. Or it may lie in an aponeurosis, so that it is practically under the same conditions; or it may be so deep at the bottom of a wound, and close against the periosteum, that an extensive incision and prolonged dissection would be required to get near it. In such cases as these a curved needle may be passed beneath the bleeding point and a figure-of-eight ligature placed over the two ends, as in the twisted suture, or a straight needle may be passed beneath or over the vessel and then thrust into the tissues in a different direction, so as to close it by its pressure. The length of time it should be left depends upon the size of the vessel and the condition of the wound (Fig. 43).

*Forcipressure* is admirably adapted for securing with rapidity a number of

small bleeding vessels. Catch forceps are used with strong, bluntly-serrated ends the bleeding point (with as little of the tissue round it as can be managed) i seized, the blades clamped together over it, and left for a few moments while th operation is continued or others are being caught. On removal the crushed en forms a flat band which does not open out again; the internal and middle coat which are broken across by the pressure, curl up inside and a coagulum forms a once. It is as efficient as torsion for all small vessels and much more rapid, and in many operations (such, for example, as excision of the breast) enables the use of ligatures to be dispensed with altogether.

*Torsion.*—When a limb is torn off the large vessels rarely bleed; the inner coats of the artery shrink up inside to such an extent that the end is completely closed and a coagulum forms at once. Torsion acts on the same principle. It may be carried out in different ways, unlimited or limited. In the former the end of the artery is seized with a pair of broad-ended serrated forceps, clamped, and then twisted around as far as its natural connections allow, or sometimes twisted off altogether; in the latter the artery is drawn out in the same manner, but fixed with a pair of forceps placed upon it transversely about a third of an inch from the end, and this projecting part is twisted until it no longer uncoils itself (Fig. 44).

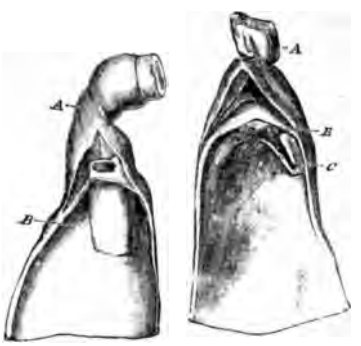


FIG. 44.—Effects of Torsion upon an Artery, showing the Incurvation and Laceration of the Inner Coats. From paper by Bryant, "Med.-Chir. Trans.," 1868.

There is no question as to the very great advantages that torsion possesses. It is better than forcipressure, for while the end is crushed in the same way into a flat riband, the internal and middle coats, instead of being merely broken off, are coiled up and rolled around together inside. There is no ligature to be absorbed (although now that catgut is chiefly used this is not so material), and temporary closure does not depend upon the security of a knot; in other words, there is no fear of recurrent hemorrhage from this giving way. The end of the vessel, i suppuration occurs, sloughs off, it is true, but so it does with a ligature. If, on the other hand, the wound heals at once, it rapidly becomes organized into a cicatrix. For plastic surgery there is no doubt as to its superiority, for even catgut, however prepared, is a foreign body and diminishes the chance of primary union. The largest vessels can be secured with perfect safety, and even when they are diseased, if the surrounding tissues are caught and twisted up with the end, a conical cap is formed which is sufficient to resist internal pressure until (unless nutrition is exceedingly feeble) organization takes place.

*Ligature.*—This is the only method of universal application (although in many cases torsion or forcipressure is preferable), and the only one by which an artery can be safely secured in its continuity.

1. *When the Artery is Already Divided.*—If the vessel is of any size the end is seized with a pair of artery-forceps and drawn out from its sheath; if it is small it must be separated carefully from the adjacent tissues, and the ligature tied firmly around it in a reef knot. An attempt should always be made to divide the internal and middle coats, but care should be taken not to cut the artery through; the amount of force required is very slight. An internal clot begins to form almost immediately, and usually it reaches up the vessel as high as the next larger branch. Lymph pours out from the vasa vasorum and the capillaries in the tissues near; organization begins, and, if the wound heals at once without suppuration, the end of the vessel, the sheath, and the tissues around it are welded together into an inextricable mass of cicatrical tissue.

The fate of the ligature and of the portion of the vessel it surrounds depend

Except in special cases, ligatures are made of finely twisted silk, soaked previously in a five per cent. solution of carbolic acid, or of catgut prepared with carbolic acid and kept in carbolic oil. It answers better if the catgut is hardened first, after Lister's plan, in chromic acid, as otherwise it is absorbed too soon. Silk, if the wound heals at once, is encapsuled in the cicatrix, the included portion of the vessel gradually becoming absorbed, owing to the pressure around it. Exceptionally, after lasting perhaps many weeks, the ligature gives rise to a certain degree of irritation, cuts its way through, and comes out. Catgut, on the other hand, unless it is very old, disappears completely, the length of time it lasts depending upon its age, thickness, and method of preparation. If it has been tied tightly, the included portion disappears too; if loosely, it may remain unabsorbed, and then, at least in the case of an artery ligatured in its continuity, it becomes a source of weakness rather than otherwise. If suppuration sets in the ligatures, whether of silk or catgut, come away, cutting through the vessel, and the distal end sloughs.

2. *Ligature of a Vessel in its Continuity.*—When an artery has to be tied *in situ* the conditions are very different from when it presents on the face of a stump. In the latter case the end is seen and drawn down from the sheath into which it has shrunk, the internal and middle coats are divided, and the artery begins to contract, as well as retract, at once. It has, comparatively speaking, lost a great deal of its importance; the femoral artery, for example, in a stump contracts almost immediately to less than half its previous diameter; the amount of tissue it has to keep supplied with blood is reduced, and though what is left has more work than usual, owing to the amount of repair, the blood-pressure falls proportionately. An artery tied in its continuity is under totally different conditions; two ends have to be closed instead of one, retraction cannot take place in the same way, and the pressure is not in the least diminished; there is as much tissue to be supplied after the operation as there was before.

The operation consists in exposing the artery at the selected spot (anatomical details chiefly determining where this may be), opening the sheath of the vessel, passing the needle around it with as little disturbance as possible, withdrawing it threaded, and then tying the ligature without lifting the artery out of its bed.

Repair is very much slower at the distal end than at the proximal; the internal clot is always smaller, and is often absent; retraction is much less complete, and secondary hemorrhage, when it occurs, nearly always comes from this. Why it should is not so clear; the vasa vasorum are interrupted, but this alone will hardly account for it, and the arterial pressure on that side must be much lower than on the other.

Many attempts have been made to diminish this liability. Compression with a ligature has been tried, the internal and middle coats being carefully preserved from injury; and there is no doubt it succeeds in animals. A ligature that will last for some time without causing irritation is tied around the vessel, just tightly enough to close the cavity without dividing the coats; a coagulum forms inside, organization follows, and, before the ligature has lost its holding power, the lumen is completely sealed. Silk may be used for this purpose, but, as it is always liable to cause a certain degree of irritation, a thick, round cord of specially prepared catgut is preferred. Barwell has made use of a flat band, cut from the aorta of an ox, with the same idea. Probably kangaroo-tail tendon is better still, as it possesses great power of endurance, and can be secured more easily. In some cases a knot has been dispensed with, and the ligature fastened somewhat after the manner of a clove hitch; for there can be no doubt that when ulceration of the vessel-wall does occur, it usually gives way opposite the projection it forms. But these results, however good they have been, have not yet convinced surgeons that (except perhaps in the case of the innominate and common iliac) compression is safer than division. Too great force, it is admitted, should not be used; but a tight ligature is certainly safer.

There is more to be said in favor of a double ligature with division of the

trunk between. If this is done, the ends retract at once (in the case of th femoral upward of half an inch) owing to the elasticity of the vessel; and th condition is assimilated much more closely to that of ligature upon the face of a stump. Prepared silk, catgut, or kangaroo tendon may be used, and the ligature should always be tight. If there is no suppuration, the ends of the vessel and the portion of tissue included in the ligature are invaded by lymph and replaced by cicatricial tissue. The permanent closure takes place by the organization of the little button of exudation that is formed in the base of the internal clot, between the retracted edges of the inner and middle coats, and in the short contracted space between this and the ligature. If suppuration does occur, and the ligature cuts through, the more perfect retraction undoubtedly diminishes the danger.

*Styptics* are substances which either cause intense contraction of the vessels or hasten the coagulation of the blood. Perchloride of iron, turpentine, alum, subsulphate of iron, and matico leaf are chiefly recommended; but, wherever it is possible, other remedies should be tried again and again instead. They altogether prevent union by the first intention, and cause a very great deal of inflammation. However, in some cases in which there is persistent rapid oozing, which nothing seems to check, they do succeed. The surface of the wound must be rendered absolutely dry before any one of them is applied.

**Choice of Method.** 1. *When the Artery is Exposed on a Stump.*—Small vessels contract under the influence of heat, cold, or exposure, and if pressure is applied afterward give no further trouble. Forcipressure is useful for larger ones; torsion or ligature for the largest. Styptics, acupressure, plugging, and other remedies are only employed under special conditions. Pressure and elevation should never be neglected. If the end of the vessel can be seen, it is safer to secure it with a ligature, even if it does not bleed at the time.

Whether torsion or ligature is the better when the walls of the vessel are diseased is an open question. If torsion is used, sufficient of the tissues round must be included to form a cap over the end. If ligature, a broad and rather stout strand of catgut should be chosen, and some of the tissues round should be included so as only to compress the vessel; a tight ligature would cut it in two at once. The great hope in these cases lies in early union; the ligature or the twisted end of the vessel can be relied upon for a week or ten days. If union round the artery is fairly sound at the end of that time, it is probably sound inside as well, and the organized coagulum will hold; if suppuration takes place, or if nutrition is so feeble that organization fails, the end of the artery perishes, and secondary hemorrhage is only too probable.

2. *When an Artery is Injured in its Continuity.*—If it is exposed at the bottom of a wound, bruised but not divided, two ligatures should be placed upon it, one above, the other below, and the trunk severed between. When it is wounded, the rule is imperative, for if one end only is tied, the other bleeds profusely as soon as the collateral circulation is established, and though the stream may not be so forcible it is equally persistent.

If it is not exposed and the hemorrhage is severe, a tourniquet must be placed upon the trunk higher up, and the wound enlarged by careful dissection until the bleeding point is found. If this is not done, it is impossible to be certain whence the hemorrhage comes. Tying the trunk of the vessel higher up, even supposing it were certain to be the right one, does not succeed; either the collateral circulation is good, and then secondary hemorrhage occurs from the distal end; or it is bad, and gangrene results.

[The "Golden Rule" of Guthrie: "*Tie both ends of the bleeding vessel in the wound, enlarging the wound if necessary.*"]

To these rules, however, there are a few exceptions:

1. Punctured wounds of the tonsil, or behind the angle of the jaw with severe arterial hemorrhage. Exposure of the bleeding point by dissection is out of the question; the common carotid must be tied in the hope of checking the hemor-

### 2. *Secondary Hemorrhage.*

This is due to failure in the measures by which permanent arrest is effected. Either the amount of lymph poured out is insufficient, or it does not become vascularized and organized in time; or, owing to the presence of some additional irritant, inflammation sets in, impairing the nutrition, not only of the newly formed lymph, but of the vessel-wall as well. Whatever it is, whether the artery is on the face of a stump or has been tried in its continuity, a slight amount of blood-stained discharge is noticed one day, usually about the time the ligature takes to cut through the vessel; the next there is a little more; and then suddenly, from some accidental exertion, coughing or straining at stool, there is a furious outburst. Fortunately there is nearly always a warning.

**Causes.**—Secondary hemorrhage is due to the same causes that delay healing of wounds in other structures.

(*a*) *Constitutional.*—Pyæmia, septicæmia, renal disease, and other conditions that interfere with all reparative processes, strongly predispose to it.

(*b*) *Local—Malnutrition of the wall of the vessel,* whether arising from atheroma or because it has been separated from its sheath. Clearly, if the wall of an artery is already badly nourished, it is not likely to repair the results of an injury readily.

*The addition of some other irritant* is the most common cause of all. The ligature itself is one, although it may be very slight; but with this already present only a little more is required, and that little is easily supplied. Want of rest is a common cause, straining, rough transport, or rough handling, for example; the neighborhood of a large collateral branch with its constant pulsation is another; but by far the most important is the presence of suppuration. If this occurs in a wound it always attacks the weakest tissues, those already injured by a ligature; the wall of the artery becomes soft and yields, and organization in the inner clot fails. For this reason, secondary hemorrhage is much more common in wounds that are complicated by suppuration than in those that are repaired without.

*Premature yielding of the ligature* is very serious. In animals no ligature is required; it is sufficient if the inner and middle coats are divided so that they can curl up; or if a ligature is used, it simply need be placed round the vessel so as to compress it; but in man this cannot be relied upon. If the ligature yields too soon, whether it is prematurely absorbed or the knot gives way, the outer wall loses its support before the internal organization is complete, and then there is always danger of the protecting barrier failing and secondary hemorrhage taking place.

**Treatment.**—This depends upon whether the artery is on the face of a stump or has been ligatured in its continuity.

(*a*) *On a Stump.*—Pressure and elevation should be tried first, but if it continues the bleeding point must be sought and found, even if it is necessary to open up the flaps again and break down all, or nearly all, the union. The only exception is when the stump is almost healed, and it is tolerably clear, from the effects of pressure, that it is either the main vessel itself or an immediate branch. In these circumstances the brachial may be ligatured for an amputation immediately below the elbow, the subclavian when the limb has been removed at the shoulder-joint, and the common femoral if at the hip.

If the stump is sloughing (as it often is in these cases) the artery must be dissected up some little distance and tied well above the infected part. The actual cautery answers for the time, but if the vessel is of any size it cannot be relied upon.

(*b*) *When an Artery has been Ligatured in its Continuity.*—Rest, cold, and pressure should also be tried here first, but if the warning is repeated, or if the loss is at all considerable, it is better not to delay further. It is true that some cases have lived through repeated hemorrhages and have recovered, but many more

have died; and there can be no question, so far as the lower limb at least is concerned, that the wound should be opened up (a tourniquet being placed on the vessel above), the two ends deliberately dissected clear and ligatured. In the upper limb, the artery (especially the brachial) has been tied nearer the trunk with occasional success, but the anatomical conditions here are very different. If this treatment fails, amputation must be performed.

### 3. *Arterial Hæmatoma.*

This condition is exactly equivalent to that of any artery ruptured subcutaneously, and must be treated in the same way. There is no sac, simply a widespread extravasation with, if the vessel is a large one, interruption of the circulation and threatening gangrene beyond. If it is the axillary, an attempt may be made to turn the clot out through a free incision and tie both ends. If the femoral or the popliteal, and the patient is young and the rest of the arteries healthy, the same may be done; but if the conditions are not perfectly favorable in other respects, amputation is the only hope.

### 4. *Traumatic Aneurysm.*

Sometimes, when repair is incomplete, a traumatic aneurysm forms in the same way as after partial rupture. Either the cicatrix or the injured coats are not sufficiently strong to resist internal pressure, or they are not supported well enough from outside, and they gradually yield and stretch. It is only so long as the aneurysm is very small that the relation they bear to it can be traced; as soon as it forms a perceptible enlargement the tissues that surround it, consolidated by the pressure and thickened by slight inflammation, constitute the outer part of the wall, while the inner surface, as in aneurysms that result from disease alone, is lined with laminated fibrin. The course, terminations, and signs of a traumatic aneurysm are identical with those of the ordinary variety; the difference consists in the condition of the rest of the wall of the vessel. As it is perfectly healthy quite up to the sac itself, ligature may be practiced in any part, near it or far from it, above or below, that offers the best prospect of cure. Many of these, however, recover without operation, under pressure or flexion.

FIGS. 45 and 46—Aneurysmal Varix.

### 5. *Arterio-venous Aneurysm.*

This and the remaining form, aneurysmal varix, are met with under the same condition, when an artery and a vein have been wounded at the same time and place and repair has not been perfected.

In aneurysmal varix there is no sac, merely the direct communication of an artery with a vein; the artery is somewhat dilated above, much contracted below, while the vein is enlarged, thickened, tortuous in all directions, and pulsates strongly. The limb below is usually wasted, but it may be enlarged

## SECTION II.—DISEASES OF BLOOD-VESSELS.

### Angeioma.

Angeiomata are tumors composed entirely, or almost entirely, of blood-vessels. For the most part they are congenital; many, however, are not noticed for a month or so after birth, and arterial ones may not make their appearance until much later. They may be composed of arteries, veins, or capillaries, or of all three together. Sometimes they consist merely of already existing vessels enormously dilated and varicose; more often of newly-formed ones as well, and certain varieties are not unfrequently associated with other forms of congenital growth.

*Capillary angeiomata* (cutaneous nævi) have been noticed already among diseases of the skin.

*Venous angeiomata* (subcutaneous or venous nævi) may occur in conjunction with capillary ones, or independently, either in the subcutaneous tissue or in other parts. Some of them appear to be formed merely of dilated veins, others resemble rather the cavernous structure of the penis, being composed of irregular, thin-walled spaces in direct communication with arteries, and these may be associated with congenital lipomata, blood, and serous cysts, and occasionally with rapidly-growing sarcomata. As a rule, venous nævi form soft, irregular, but distinct masses, easily compressible, and filling up again as soon as the pressure is removed. Some few of the cavernous ones merit the name of erectile tumors, but there is very rarely any pulsation to be detected. Their color varies with their position. If beneath the skin they are blue, like veins; if under a mucous membrane, bright red; and their consistence varies, of course, with the amount of solid growth that is present. In many cases they remain stationary for years; not unfrequently they degenerate or become cystic; sometimes, after lying unaltered for a great length of time, they suddenly enlarge, ulcerate, and give rise to severe hemorrhage. Venous nævi must be carefully distinguished from meningocele or encephalocele when they occur at the root of the nose or at the angles of the orbit; and if there is the suspicion of a doubt, the tumor should certainly not be touched.

Various methods of treatment may be adopted, according to the size, position, and rapidity of the growth of the tumor. Probably, if in a part of the body in which they are not seen, and if there is no evidence of increase in size, the best plan is to leave them alone, certainly for a time. Excision is the most certain, and leaves an exceedingly small scar; the amount of hemorrhage is very slight. Electrolysis (using only the positive pole) is tedious but safe, and leaves no mark at all. The constant current should be used, four or six cells of Stohrer's battery. The negative pole is attached to a metal plate covered with wash-leather; the positive to one or more steel-tipped needles, insulated for about half their length. These are introduced into the nævus, parallel to each other. As soon as the current is turned on the blood begins to coagulate round them, and when they are withdrawn, a hard, dense track is left. If bubbles of gas make their appearance, it is a sign that the current is too strong. Where a rapid effect is desired the actual cautery is the most successful application. One perforation is made in the skin, and then the fine platinum point is thrust through the substance of the growth in various directions. If it is of the right temperature the pain is very slight and no blood is lost. [Electrolysis frequently fails, where the angeioma extends deeply into the tissue. The more superficial the angeioma the greater the probability of cure by electrolysis.] In other cases setons may be employed; or threads dipped in perchloride of iron; or portions may be ligatured subcutaneously or the growth may be divided in various directions with a tenotomy knife, and pressure applied afterward. In cases in which extensive nævi are associated with

rapidly-increasing solid growths in children, the outward application of strong lead lotion is of decided benefit, at any rate for a time. Injections should never be used, for fear of causing embolism.

*Arterial angeioma* (arterial varix, cirsoid aneurysm, and aneurysm by anastomosis, are other terms descriptive of essentially the same condition) is, in comparison with these, of very rare occurrence, and although it may be congenital in some instances, is seldom met with before puberty.

It is known as arterial varix when only a single artery is involved, as cirsoid aneurysm if there is a mass together, and as aneurysm by anastomosis when the capillaries and venules are dilated as well.

The most common situation for it is the scalp (especially round and above the ear), but it may occur in any part of the body. Sometimes it is stated to have developed from a nævus; in other instances it appears to have followed injury, and possibly may have originated as some form of arteritis; in the majority no reasonable cause or explanation is forthcoming (Fig. 49).

FIG. 49.—Cirsoid Aneurysm of the Scalp.

In its typical form it is composed of a mass of enormously dilated, tortuous arteries, twisted inextricably together, and covered with thin-walled pouches. It projects somewhat above the skin (which is often dangerously thin over the most prominent parts); it is soft, lobulated, easily emptied by direct pressure, and to a less extent by pressure upon the trunk supplying it; but it fills again at once, and its outline is very ill-defined, the branches that supply it only assuming their normal character some distance from the main body. A thrill and a distinct bruit can be detected over the main part, and followed along the vessels in the course of the blood-stream. By its pressure it gradually causes absorption of the structures round, cutting deep grooves in the bones, and rendering the skin so thin that it is in imminent danger of giving way. There is no pain unless some nerve is accidentally involved.

Spontaneous cure is unknown; it may remain passive for years and then again begin to enlarge, or it may grow steadily the whole time. If the skin gives way the hemorrhage is of the most alarming character, and may prove almost immediately fatal.

Excision is the only treatment that deserves any reliance. Ligature of the trunk supplying the tumor has failed far more frequently than it has succeeded, and renders subsequent operations more dangerous on account of the development of the collateral circulation. Pressure checks advance in some of the more chronic cases, but can do no more. Ligature *en masse* has answered in a few instances, although in one at least recurrence took place.

If it is on the scalp, temporary ligatures may be placed on the carotids, or the trunks supplying the tumor may be compressed with hare-lip pins, and then, with the aid of one or two assistants to keep up digital compression while the ligatures are being placed and tied, the skin may be reflected from part of it, and the rest of the growth excised with the minimum of loss. If it is on the extremities the same plan may be tried, but in several cases amputation has been found necessary, sooner or later.

## HÆMOPHILIA.

Hæmophilia, or the hemorrhagic diathesis, is a peculiarity of constitutio that is distinctly hereditary; but though it may be transmitted by mothers to the sons, it is very rarely manifested except in males. Female children themselve are very seldom affected.

Nothing is known as to its cause; no definite change is found constantly i the walls of the vessels, and there is no apparent alteration in the blood. At fir it coagulates as readily as usual, and though after a time it becomes thin an watery, the same thing occurs after profuse hemorrhage from people who are nc bleeders. The aspect or appearance is not in any way characteristic, and before hand there is nothing to tell whether a patient is a bleeder or not. The tendenc to it is most marked in infancy and childhood; if it does not develop then th patient, as a rule, remains free. In a few instances it seems to have spontaneousl died out, and in all probability the tendency to it varies in intensity at different time

In some, the bleeding is spontaneous, coming from mucous or synovial sur faces, in others it is traumatic only. The slightest injury may cause it; bruise are followed by enormous extravasations in which the blood remains fluid for a great length of time, and the extraction of teeth is especially serious. It is sai that trivial injuries are more often followed by bleeding than grave ones, but thi is open to question. It is not arterial or venous, the blood simply appears t pour out from the tissues themselves in a ceaseless stream.

Spontaneous hemorrhages are stated to be often preceded by symptoms c congestion, but they more usually occur without warning. When the joints ar involved it is not infrequently taken for rheumatism, especially as there is decided tendency for it to occur in cold and damp weather. The swelling sudden, involving the peri-synovial tissues as well as the cavity of the joint ar accompanied by ecchymoses. Permanent enlargement, and even ankylosis, ma follow if the attacks are repeated. The mucous membrane of the nose and th of the gastro-intestinal tract are the most frequent seats, but in some the bleedi comes from almost every part.

No special treatment is of any avail. Internal styptics have been used freel and every kind of external one, without success. Not unfrequently the patie continues to lose blood until not a drop seems to be left, and then rapidly begi to recover; but they rarely reach old age or even adult life. In the case of teet carefully applied pressure is the most successful; a cork should be fitted into t hollow, the cavity thoroughly packed, and then the teeth of the other jaw press tightly against it by means of a webbing strap around the head. In this way have succeeded in checking it in several members of a well-known family. T actual cautery seems to be of no special use, and of course no measure th involves a wound should ever be attempted. [The editor has known one case persistent hemorrhage that was due to long-continued use of sulphate of quinine

the nature of the irritant; some is absorbed, the rest becomes vascular and is organized into a cicatrix. If the ligature disappears without causing a sufficient degree of irritation, or if the tissues are so badly nourished that they are unable to carry out active repair, the cicatrix is very likely to be too weak and to yield to the strain that falls on it.

Similar changes occur after wounds, bruises, and the impaction of non-infective emboli.

### 2. *Suppurative Arteritis.*

This may begin in the interior, from the presence of an infective embolus, or on the exterior, as peri-arteritis. In the latter case the organisms generally enter through a wound, but when, for example, there is a suppurating aneurysm, they must reach the part either through the blood-stream or the lymphatics; the constant pressure and tension irritate the tissues and break down their power of resistance, and the pyogenic germs, which otherwise are innocuous, at once begin their work of destruction.

In pyæmic embolism, whether infarction occurs or not, the destruction is so rapid and so general that the changes in the wall of the artery cannot be distinguished, the tissues melt at once into intensely infective pus. When, however, the suppuration begins in the outer coat, after ligature, for example, the course of events can be traced fairly well. The vasa vasorum dilate and become sheathed with leucocytes, the fibrous tissue melts away, the muscular bands split up, the endothelial cells perish and become detached, and at length, although the wall of an artery resists better than most structures, it is gradually eaten through or so weakened that it gives way. As a rule, before this occurs the white corpuscles collect upon the inflamed wall and form a protecting thrombus.

The subsequent course depends upon the intensity of the irritant on the one hand and the activity of nutrition upon the other.

(*a*) If there is no additional cause at work, no tension, mechanical irritation, or absorption of septic products, the suppuration may cease, the tissues gaining the upper hand, and the wall of the artery remain intact, as, for example, usually occurs when a vessel is exposed upon the floor of a simple ulcer; or the result may not be quite so good; one part of the wall, for example, may be so weakened that it yields and forms an aneurysm, or the interior may be completely closed by a thrombus, or part of the artery may perish and slough, loss of blood being prevented by the sealing of the ends.

(*b*) If, on the other hand, the vitality of the tissues is too much impaired for organization to be effectual (as in phagedæna), or if some other irritant appears upon the scene (especially septic decomposition), the germs prove themselves the stronger and the tissues give way. The wall of the vessel is softened, the clot disintegrates before it is organized, and secondary hemorrhage occurs.

This accident may happen when a wound heals by the first intention, and even after it has healed, if the cicatrix is thin and weak and the structures around soft and yielding; but it is much more common after suppuration, especially if the nutrition of the tissues is impaired, whether from pre-existing atheroma or from septic decomposition.

A special form of embolic arteritis is met with in connection with ulcerative endocarditis. The vegetations detached from the valves sometimes cause suppuration, as in pyæmia; but not unfrequently they merely give rise to a certain degree of softening and inflammation, by which the walls of the vessels are unduly weakened. In all probability a very large number of the aneurysms that occur in young children may be accounted for by this, the dilatation beginning opposite the embolus, not above it.

### 3. *Syphilitic Arteritis.*

Arterial disease is of common occurrence, both in acquired and hereditary syphilis, especially in the brain. Probably the apparent frequency with which

this organ is involved may be explained by the gravity of the symptoms th follow, by the fact that its vessels are easily examined, and by the anatomic peculiarities of their lymphatic sheath. Usually single vessels only are affect and often only small portions of them (Fig. 50).

FIG. 50.—Syphilitic Disease of One of the Cerebral Arteries. The inner coat is thickened by fibrous tissue, and the lumen is much narrowed. (*Bowlby.*)

The exudation is similar to tha which occurs elsewhere, with, however, a special tendency to fibroid transforma tion; it is doubtful if it ever calcifies. Sometimes it commences as a peri-arte ritis, distinct gummata forming on the vessel and occluding it more or less by their pressure; more frequently, how ever, it involves the deeper layers of the intima, causing such an enormous degree of thickening that the interior of the vessel is almost closed. If the endothelial lining is involved as well, a thrombus forms over the affected part, and renders this complete. In the brain this may lead to white softening, from the blood-supply being cut off, or to aneurysm. In the most fortunate examples the exuda tion is absorbed again more or less com pletely, leaving, however, the vessel tortu ous, inelastic, and weakened, so that it is always liable to give way.

Similar changes are found in the vessels of gummata, and it has been sug gested that the consequent diminution in the amount of blood they receive is th immediate cause of the degenerative changes they undergo as soon as they reac a certain size.

### 4. *Arteritis Obliterans.*

This name has been given to a peculiar form of inflammation, which some times occurs in arteries during middle life. Nothing is known as to its pathology It is exceedingly chronic in its course, beginning in the smaller vessels and steadil involving the larger ones, causing them first to become hard and thick, and the gradually closing them. It is often accompanied by very severe pain and usuall ends in dry gangrene. When it occurs in younger subjects, especially in the arm it is very liable to be confused with occlusion of the artery caused by deep-seate growths, especially cervical exostoses.

### 5. *Gouty Arteritis.*

A few cases are recorded in which a moderately acute attack of periarterit has occurred in gouty subjects past middle life, possibly, therefore—as syphili injury, and all ordinary causes could be eliminated—due to gout. It has bee noted in the temporals with a certain degree of redness of skin and tenderne over their course, and in the brachial. Usually it ends in thrombosis and obliter tion, the ultimate consequences, of course, varying with the collateral circulatio

Tubercular infiltration of the perivascular sheath of the cerebral arteries of common occurrence, and certain facts render it probable that occasionally tube cular masses rupture into arteries and cause embolism (especially in connectio with the bones), but no definite tubercular arteritis has yet been described.

### 6. *Chronic Arteritis or Atheroma.*

Chronic inflammation, with its consequence, atheroma, is very common i late adult life, although probably its beginning is laid at a much earlier period

The larger vessels are chiefly affected, and those parts upon which the strain is greatest, the arch of the aorta for example, the origin of branches, the spot where the external iliac becomes the femoral, and generally the convexities of all the curves; but the arteries of the brain, especially those at the base, those of the lower limbs, and, in the abdomen, the splenic, suffer almost as often.

It can be traced to the effect of strains, sudden or long continued. It is more frequent in men than women, it affects those especially who have to undertake suddenly great physical exertion, and it involves those parts of the vascular system which are the first to feel such effects. The pulmonary artery, for example, is always exempt unless there is some obstruction to the flow of blood through the lungs, causing hypertrophy of the right ventricle; then it suffers equally. Alcohol helps to produce it, and so do plethora and gout, for much the same reason, but it is doubtful if syphilis has more than an accidental connection. Bright's disease and arterio-capillary fibrosis are especially likely to be followed by it.

Its first appearance is as a gray semi-translucent spot, slightly raised above the surface; this grows larger and larger, coalesces with others like it, becomes more yellow in color, and at length forms a distinct elevation, elongated or circular in shape, according to the part of the artery in which it is situated. It is caused by an inflammatory exudation into the subendothelial cellular layer, immediately under the lining of the vessel. Probably it begins here, partly because the texture is somewhat looser than elsewhere, partly because it is the first to feel the strain. The middle coat is but little affected until the muscular fibres begin to waste, then it yields, loses its elasticity, and becomes rigid. The outer, on the other hand, is usually involved nearly as much as the inner.

In some instances the exudation may disappear again, leaving the wall intact, but of this naturally there is no evidence. As a rule it either becomes fibrous, forming firm, slightly raised, yellow patches, still covered with endothelium; or undergoes degeneration, either fatty or calcareous, or both together. Not unfrequently the outer portion becomes organized, while the inner decays.

The reason of the difference is probably to be found in the condition of the blood-supply. The vasa vasorum ramify in the outer and middle coats, but do not supply the sub-endothelial layer; this is nourished chiefly or entirely by diffusion through the endothelium. When inflammation sets in, and the lymph-corpuscles increase in number, so simple a process as this is insufficient, and degeneration begins before new vessels can develop. On the other hand, in the outer layers, where the blood-supply is much more abundant, organization is the rule.

Fatty degeneration is marked by a change in color and consistence. The patch becomes more yellow, it grows softer and softer, so that in extreme cases it is almost fluid, and then suddenly the endothelium gives way, and the contents—fatty molecules, cholesterin, and crystals of stearin—are discharged into the vessel. Fortunately they do no harm, beyond blocking up perhaps some minute branch; but an *atheromatous ulcer* is left, an excavated, ragged spot, often of considerable size, with the endothelium gone, the tunica media softened and weakened, and the integrity of the vessel only maintained by the thickened, inelastic outer coat, which is fused with the structures round.

Calcareous degeneration is usually secondary to this, the fluid part disappearing, and the caseous debris left becoming infiltrated with lime-salts until it forms an irregular plate, lying in the wall of the vessel, exposed more or less to the blood-stream, and not unfrequently projecting into it at some point.

The appearances produced by these changes are naturally very variable. The artery may be dilated along its whole course, or here and there; not unfrequently it is elongated and tortuous, while the walls are rigid and inelastic, thickened in places and tied down by adhesions to the sheath, dangerously thinned perhaps in others. The inner surface is still worse; in some parts there are firm, raised nodules of a grayish color, still smooth; in others the endothelium has given way, leaving a ragged excavation with fringed and overhanging edges, lined with

caseous debris or calcareous plates, and in others again the irregularities are c cealed beneath adherent thrombi. Rupture sometimes occurs in the arteries the brain in which the adventitia is poorly developed; elsewhere it is unusual the outer coat becomes thick enough to resist.

The loss of elasticity and the destruction of the surface are soon followed worse results. The walls stretch and yield, the vessels are thrown into curves loops, so that what is known as a locomotive pulse is produced; the parts bey are ill-nourished and ill-supplied with blood, and as enlargement, of the collat circulation is impossible, the least difficulty is liable to be followed by gangr It is by far the most common cause of aneurysm, sacculated as well as dissecti If, as usually happens, one part of the wall becomes weak and soft from inflam tion, without an extensive degree of atheroma, the sacculated form is produc If, on the other hand, degeneration occurs at an early period, so that the lin membrane ruptures before the coats are welded together, the dissecting one lows, and the blood works its way down, between the layers of the wall, unti either bursts into the vessel again, or breaks the outer coat and pours into the sues round. Thrombosis is even more common, the blood coagulating upon irregular projections, and perhaps completely occluding the vessel. Embol may occur, or the orifices of the small branches (the coronary arteries, for instan may be closed by the contraction of the fibrous tissue round them; or rupt may take place, or, in short, almost any of the troubles that can happen in c nection with the blood-vessels or the blood supply.

The importance of atheroma in the production of secondary hemorrh cannot be over-estimated. Clearly, if the walls of the vessels are badly nouris and inflamed already, immediate repair after injury is hardly probable. Fo nately, the change is often local, and if, for example, the popliteal is diseas the femoral in Hunter's canal may be sound.

### Degeneration of Arteries.

The coats of arteries are liable to degenerate and decay as age adva without any preceding inflammation, although naturally the two are often a ciated, and the same thing is met with in younger people as a result of marasm anæmia, and exhausting illness.

#### *Fatty Degeneration.*

Fatty degeneration of the intima is not unusual in the aorta; apparent begins in the stellate sub-endothelial cells of the intima, and forms opaque yel sharply outlined patches, which may be distinguished from atheroma by the that they are superficial and scarcely raised. The deeper parts are quite heal It has no clinical importance.

When, on the other hand, it involves the media, especially in the case of brain, the wall is so weakened that there is imminent danger of rupture.

#### *Calcareous Degeneration.*

This is especially liable to occur in the cerebral arteries and in the tibial old people. It involves the middle coat chiefly, and appears to be a prin calcareous degeneration of the unstriped muscle-cells. They gradually disap and are replaced by calcified rings, which fit so closely together and are so merous that the artery becomes converted into a calcified tube. Ultimately intima is affected too, but this does not occur so early or so extensively a atheroma; the adventitia sometimes becomes hypertrophied so as to forn protecting sheath; sometimes, on the other hand, it wastes away and nothing these calcified rings is left. The effect upon the circulation is, of course, exc ingly grave: the loss of elasticity impedes the flow of blood and prevents

of no importance. Sometimes the whole length is involved, more often only parts of it here and there, the intermediate portions being altogether normal; or the main trunk may be intact and the branches varicose, or only the minute tributaries, the venules in the skin, dilated. The deep veins of the leg (but not those of the thigh) are often affected to a greater extent than the superficial ones, and the disease may commence in them; very often it shows itself first where the two sets of branches communicate with each other. The external saphena suffers almost as often, and not unfrequently the whole of the foot or ankle is covered with a network of tortuous dilated vessels, running apparently indiscriminately. In other parts of the body (except in connection with the testes, labia, and rectum) varicose veins are rarely seen unless there is obstruction of one of the great trunks.

Varicose veins are not only dilated, but lengthened and thrown into loops and curves. In some places the walls are immensely thickened by the fresh development of fibrous tissue, so that when the vessels are cut across they remain gaping widely open with little or no tendency to contract. In other parts they are thinned and stretched, and so twisted up together that they form an ill-defined spongy swelling resembling cavernous tissue. The valves have often disappeared altogether or are reduced to shreds, which have no power of preventing regurgitation or supporting the column of blood. The skin is sometimes thickened, but more frequently it grows thinner and thinner, until the vein almost protrudes through it, and even the bones beneath may be grooved and cut into deep channels by the persistent pressure.

**Symptoms.**—Varicose veins, so long as the circulation and nutrition are good, give rise to very little inconvenience, merely a sense of aching or of weight after exercise. Occasionally, possibly because a nerve is pressed upon, there is more acute pain, and it is believed that deep-seated muscular varices are sometimes the cause of painful cramps. The diagnosis rarely presents any difficulty, the color, shape, distribution, and the difference in tension according to position are sufficiently characteristic. There may be a distinct impulse in coughing, especially when the upper part of the internal saphena is dilated, and it is said that this condition may simulate femoral hernia.

If, however, from any cause—age, ill-health, over-exertion, fatigue, etc.—the circulation begins to flag, the dilatation, the enormous weight of the column of blood, greatly increased in diameter and unbroken by valves, and the loss of vascular tone, soon produce, or help to produce, much more serious effects. Chronic congestion, with œdema and more or less thickening and hypertrophy of the connective tissue of the part, is the first thing to happen. The red blood-corpuscles escape through the walls and cause deep pigmentation. The general nutrition of the tissues fails, chronic ulcers form, trivial injuries are not repaired, but leave behind them persisting sores; the skin becomes irritated and eczematous, and at last—not so much because of the varicose veins themselves as because of the general failure of the circulation of which they are but one of the signs—the whole limb becomes more or less affected.

Thrombosis is an exceedingly common complication, the blood coagulating in one of the outlying parts; sometimes the clot is absorbed, more frequently it becomes organized or undergoes degeneration. Phleboliths produced in this way can nearly always be found in the prostatic plexus. Occasionally the skin over the vein gives way, and very serious hemorrhage results.

**Treatment.**—1. *Palliative.*—All obstructions must be removed as far as possible. Tight garters are exceedingly injurious. In pregnancy the patient must rest as much as possible, or as is consistent with health, and wear a bandage or a stocking both during and for some time afterward. The bowels must be kept well open, and long standing and excessive walking avoided, although a reasonable amount of exercise, stopping short of fatigue, is decidedly beneficial.

If the varix has made its appearance suddenly after exertion, the walls of the vein must be carefully protected from strain for some considerable time. The limb

should be kept at rest, in the horizontal position, for two or three weeks, according to the size of the vein, and then carefully supported.

In the majority of cases all that can be done is to caution the patient against the evil effects of standing, etc.; maintain the general health by means of tonics, combined with good food, fresh air, and a fair amount of exercise, and supply some kind of support. Silk anklets, elastic stockings, and the appliances generally in use serve the purpose for which they are intended very ill; they produce the maximum of constriction when first applied, and then each week relax more and more until replaced; they are usually much too tight, and generally cause considerable wasting of the muscles. If worn once the limb becomes so used to their pressure that the patient can hardly be induced to leave them off. Bandages of thin flannel, domet, or perforated rubber are much better, as they can be put on with just sufficient pressure and no more, instead of an iron rule being followed in all cases alike.

Upward friction and massage should be practiced every night when the appliance is removed. If bleeding threatens, the part should be well bandaged and kept at rest; if it breaks out (the usual situation is the lower third of the leg) the limb must be raised at once. The hemorrhage is exceedingly profuse, but it comes from the proximal or cardiac end, and raising the limb stops it instantaneously. If inflammation sets in and the veins become hard and painful, showing that they are filled with clots, the patient should be confined to bed, the limb placed in a slanting position on a leg rest, and covered with lead lotion.

2. *Radical.*—In a certain number of cases the radical cure may be tried. As a rule, it is only advisable where the superficial veins are concerned, and where the part involved is limited in extent. Sometimes, however, it is beneficial in cases of varicose ulcer, in which the persistence of the sore appears to be dependent upon the vein. I have known an ulcer heal while the patient was in bed recovering from the operation, and remain sound for fifteen years afterward, although previously it was always relapsing.

The choice lies between acupressure (with or without subcutaneous division), ligature, and excision.

(*a*) *Acupressure.*—This is performed by passing a flat needle beneath the vein, while it is pinched up with the finger and thumb, and then twisting a figure-of-eight suture over the ends, protecting the skin beneath by means of a piece of bougie or quill. The needles should be about three-quarters of an inch apart, and the vein may be divided subcutaneously with a tenotomy-knife between them. They should not be left in for more than a week, and if any inflammation occurs this time should be shortened. Failure is not infrequent and there is always the risk of transfixing the vein.

(*b*) *Ligature.*—A small incision is made over the vessel, an aneurysm-needle passed round it and threaded with catgut. The ligature left when the needle is withdrawn is tied and the ends cut short. This method may be combined with the former, ligatures being placed in the intervals between the pins.

(*c*) *Excision.*—This is by far the most effective method, but it is only suited to a very limited number of cases. The skin is reflected from off the vein, the incision being as far as possible longitudinal; the vessel is carefully isolated from the surrounding tissue, a double ligature (catgut) is placed round it at each end and round each branch, and the whole intervening portion excised. Where any great length of vein is involved this is, of course, impossible, but the comparatively isolated bunches of veins that are frequently met with on the inner side of the lower third of the thigh and leg can often be treated very satisfactorily.

## Thrombosis.

A thrombus is a clot that develops inside the heart or one of the vessels during life. It is distinguished from a post-mortem coagulum by the fact that it is drier, harder, less elastic, and distinctly adherent to the interior.

Red thrombi are formed in stagnant blood, white ones in that which is still circulating. The former are uniform all through, the latter are built up in strata, some of which are more colored than others. Very often the two occur side by side, a white one forming first and gradually blocking up the passage until suddenly coagulation becomes complete.

**Causes.**—Thrombosis is due either to some alteration in the wall of the vessel, to some change in the blood, or to both causes together. It occurs chiefly in those parts in which the circulation is most feeble, beginning, for example, in the dilatations of varicose veins, or behind valves; where, on the other hand, the stream is rapid and forcible, as in the central part of an aneurysm, it may be delayed for a great length of time.

(*a*) The least change in the condition of the lining membrane is sufficient, whether due to injury, inflammation, or degeneration. The blood-plates are deposited at once upon any surface that is not perfectly healthy, and then the fibrin begins to collect. Foreign bodies introduced into the blood-stream naturally cause this at once. Stagnation very probably acts in the same way. In typhoid, advanced phthisis, and other exhausting diseases it is not uncommon for clots to form quietly, without any injury or inflammation, in the veins of the lower extremities. These apparently commence behind the valves, in the layer of blood that under such conditions remains stagnant there, the endothelium of the lining membrane losing its vitality for want of a fresh supply, and causing the blood in contact with it to coagulate. Very possibly, however, in these conditions the composition of the blood is altered too.

(*b*) It is an undoubted fact that certain conditions of the blood greatly favor coagulation, and also that certain substances introduced into the blood (including the fluids squeezed from some of the organs of the body) cause general intravascular clotting, but the extent to which this takes place in disease is quite unknown. In various forms of septic poisoning distant thrombosis is not uncommon, possibly owing to the destruction of blood-plates or colorless corpuscles, especially as there is usually at the same time failure in the force and vigor of the circulation; but the subject requires further investigation.

Thrombosis in arteries is rare except as a result of injury, inflammation, or atheroma; in veins, on the other hand, it is exceedingly common, occurring both as a primary affection and secondary to injury or phlebitis; in capillaries it can only occur when the wall of the vessel is gravely injured or actually killed.

*The changes* that thrombi undergo vary according to their locality and cause.

Venous thrombi occasionally continue to spread toward the heart, until at length they meet with a vessel in which the current is too rapid. In this way continuous clots of immense length may be formed, spreading through veins of larger and larger size, until at last the rounded end projects through a side opening into the cavity of one of the largest. Here it may stop and do no further harm, or it may be broken off and form an embolus, or, if the current fails in strength from any cause, it may reach the heart itself. This is especially likely to occur when they originate from poisoned wounds.

1. *Resolution* is not uncommon. Large masses of coagulated blood may melt away and disappear within twenty-four hours, as is seen not unfrequently in the rapid cure of aneurysm by means of Esmarch's bandage. If they last over this they are usually permanent. What becomes of the clot, how it vanishes, is not known; of course, the channel is completely restored.

2. *Organization.*—This takes place in the same way as in an artery: lymph pours out from all the minute vessels around, and gradually replaces the clot. Whether the endothelial cells or the white corpuscles in the circulating blood help or not is uncertain. Then fresh vessels form: fibroblasts develop along their course, and gradually the clot and the walls of the vein are welded together into a mass of fibrous tissue. In many cases the cavity is obliterated; sometimes, however, capillaries communicating with the lumen of the vessel above and below enlarge and form a direct connection again; or the clot shrinks to one side and

leaves part of the channel free. At any rate, it is not unusual to find, after some long period, that a blocked vein becomes pervious again, a few strands of fibrous tissue being left across the interior or clinging to one side of it, showing the fate of the obstruction. In the case of aneurysms, in which there is often an enormous thickness of laminated clot, organization is a very slow proceeding, accompanied by shrinking and fatty degeneration.

3. *Degeneration.*—Large thrombi in the interior of a vein gradually become softer and softer in the centre, turning from red to yellow, and yellow to white, until they are filled with a fluid at first sight not unlike pus, but in reality consisting merely of caseating debris. The outer walls in contact with the still circulating blood usually form a firm casing; occasionally they break down, and then the liquid contents are poured into the blood-stream, causing minute embolisms, and the thrombus is said to be *canalized.*

Sometimes, especially in the case of the small thrombi forming behind the valves in veins and in the prostatic plexus, calcareous degeneration occurs instead, and what are known as *phleboliths* are formed—small rounded and often pedunculated masses, enclosed in a fibrous sheath, and consisting mainly of phosphate of lime, with small quantities of sulphate of lime and of potash.

4. *Infective softening.*—If the micrococci of suppuration gain access to the clot, either through a local wound, through the wall of the vessel, or through the circulating blood, it becomes soft and breaks down into a fluid apparently of the same character, but in reality altogether different. Each fragment of the blood that enters into the current carries with it the germs of suppuration; wherever it becomes impacted, it cuts off the blood-supply, lowers the vitality of the tissues and renders them incapable of resisting the assault of the organisms it has brought with it; in other words, each embolus becomes the starting-point of a pyæmic abscess.

**Consequences.**—1. *Inflammation.*—Every thrombus causes a certain degree of inflammation of the wall, so that if the vessel is superficial, the skin over it becomes red and tender and the soft cellular tissue around infiltrated with lymph. If the cause is not an infective one, this ends in organization and repair, clearing up as the thrombus does; if, on the other hand, it is infective, suppurative arteritis or phlebitis follows, as the case may be.

2. *Obstruction.*—This differs very much according to the size and importance of the vessel. In the case of an artery the pulse ceases at once and the limb below becomes pale, numbed, and powerless; even gangrene may set in (the dry form) if the collateral circulation is not good. When a comparatively small vein is involved, there is little or no difficulty to the return of blood, owing to the free anastomosis in most parts of the body; but when it is an important one, such as the ilio-femoral, and any length of it is obstructed, the consequences may be very serious. This is of common occurrence after parturition (phlegmasia alba dolens) [and sometimes after fractures of the leg]; the limb becomes tense, white, and painful, the vein can be felt as a hard, knotted cord, and the weight is so great that the patient can hardly move the part. Sometimes this clears up within a very short time, the clot apparently melting away. More frequently recovery is only partial; the thrombus becomes organized, and either shrinks to the wall of the vessel, or is perforated by small anastomotic veinlets, so that the channel is opened up again more or less completely. Occasionally it persists without yielding at all, and then, especially if the lymphatics are involved as well, a condition of what is known as solid œdema sets in, often ending in what is practically elephantiasis. The skin and the cellular tissue become enormously and irregularly thickened by the growth of fibrous tissue, the natural texture of the part is lost, and the weight may be so great that the patient is almost unable to lift it.

In cases in which the anastomotic circulation is more free, as when the inferior vena cava is obstructed by a thrombus, the collateral veins become hypertrophied, so that the skin over the front and sides of the abdomen is covered with great, tortuous masses. At first, perhaps, this compensates, but

when the obstructed vein is as important as the one mentioned, it rarely suffices for long, dilatation soon begins, the limbs become œdematous and swollen, the nutrition fails, and chronic ulcers appear.

Finally, if spreading thrombosis occurs over a large area and involves the orifices of collateral branches, moist gangrene is very likely to ensue.

3. *Embolism* has been already mentioned as one of the remote consequences of thrombosis. It nearly always originates from venous thrombi and affects first the pulmonary circulation, but it may originate in the portal system. The consequences depend upon the size and the nature of the embolus.

### Embolism.

Embolism is the impaction in some part of the blood-stream of a substance which from its size or nature cannot be driven further; the substance itself is an embolus.

Emboli are derived from many different sources. A fragment of a thrombus is one of the most common. An end may be bodily torn off, especially if it projects through a side opening into the cavity of a larger vein; or the whole clot may undergo decay and disintegration, so that a mass of soft debris is discharged into the circulation at once. Vegetations are occasionally swept off from the cardiac valves, or calcareous or caseous fragments from an atheromatous ulcer. Malignant growths (especially carcinomata) sometimes perforate the walls of veins and sprout into the interior. Abscesses, whether due to pyogenic or tubercular organisms, may do the same, the coats of the vessel gradually softening until the endothelium ruptures without any protecting thrombus having been formed. Liquid fat is often forced in the blood-stream in cases of fracture, and in exceptional instances many other substances, even parasites, find their way in.

Embolism may occur either in the systemic or the pulmonary arteries, or in the portal vein, the embolus originating, as a rule, in the venous system or the heart, and, of course, following the direction of the circulation. Wherever it originates, it is swept along until it meets with some vessel too small for it to pass through. Usually this corresponds to the point of bifurcation. Then, if it is liquid, it splits up into finer ones; if soft and yielding, like a recent clot, it moulds itself to the interior; and if hard and rigid it becomes fixed and completes the obstruction by causing coagulation around.

The immediate result is to stop the current through that branch. How this affects the area it supplies depends upon the size and nature of the embolus and the perfection of the collateral circulation.

Instant death may, of course, ensue if one of the large branches of the pulmonary artery is blocked, or the middle cerebral. In other cases, however, every attempt is made to keep up the full supply of blood through the collateral branches.

*a*. If these are fairly abundant and healthy, so that dilatation is possible, no ill result ensues; there is a temporary blanching of the part, the pulse fails below and it feels cold and numb, but this soon passes off and is followed by transient hyperæmia, in which all the vessels share. Later this general enlargement of the collateral supply gradually narrows itself down to one or two of the shortest and straightest routes, and everything is restored to its natural condition.

*b*. If, on the other hand, either dilatation is impossible, or—as, for example, in the case of the retina—there is no collateral circulation, the part gradually becomes starved out and dies. If it is in the interior of the body it undergoes fatty degeneration; if it is on one of the extremities, dry gangrene.

*c*. In certain organs (the lungs and kidneys in particular) what is known as infarction occurs. The collateral circulation is not sufficiently good to maintain the full blood-pressure, but yet is developed to a certain extent; the blood pours into the anæmic area (*e. g.*, from the capsular vessels in the kidney) with sufficient strength to fill the capillaries, but not sufficient to maintain its course. As a

result all the minute vessels become engorged, stasis sets in, the walls of the capillaries perish, the red blood-corpuscles pass through and fill all the interstices, and practically, at length, the whole area is absolutely solid with blood, forming what is known as a *hemorrhagic infarct.* In the lungs this is seen in its most characteristic form, a conical mass of tissue, black and hard; the base of the cone abutting in the pleura, the apex corresponding to the embolus, and the size depending upon that of the blocked vessel. In the case of an ordinary non-infective embolus this slowly undergoes fatty degeneration, a zone of hyperæmia forming round it, and the lymph-corpuscles invading it from the exterior, and quietly absorbing it until nothing but a depressed cicatrix is left.

The effect of an embolus, however, depends not only upon its size and the arrangement of the blood-vessels, but upon its nature. So long as it is absolutely unirritating (the fragment, for example, of a simple thrombus), the inflammation it excites is merely sufficient to cause organization of the clot that forms round it and seal it to the side. In ulcerative endocarditis, however, the vegetations that are detached from the valves are often so irritating that the walls of the arteries in which they are impacted become soft and yield before the blood-pressure, so that an aneurysm is formed. And in suppurative phlebitis, when pyogenic micro-organisms have gained access to the interior of the clot, and have caused it to break down into a puriform infective fluid, the consequences are more serious still. Wherever the debris is carried, it brings with it infective germs, which find in the engorged and lifeless mass of tissue the soil that suits them best; as a result, the whole affected area melts away at once into the most intensely infective pus, and a true pyæmic abscess is developed.

### Inflammation of Veins.

Inflammation of veins may begin either in the tissues round (periphlebitis) or in the interior from the endothelial surface. It is nearly always acute; the chronic form, corresponding to the atheromatous degeneration of arteries, is seldom met with except in the thick-walled dilatations of varicose veins, and, owing to the difference in the blood-pressure, does not possess the same degree of significance.

#### 1. *Simple Acute Phlebitis.*

This is due either to injury (ligature, contusion, etc.), the presence of a thrombus, or to some morbid condition of the blood, of which gout, rheumatism, and syphilis are the best known. If a thrombus is not already present, one is formed as soon as the inflammation begins to affect the endothelial lining.

The changes that take place are those already described in thrombosis; the wall of the vein becomes thickened, softened, and more vascular, a greater amount of lymph is poured out, the endothelium changes in appearance, though whether it takes an active share in the production of the exudation is not known, and the thrombus itself, the coats of the vein, and the tissues around it are infiltrated with masses of lymph-corpuscles. The effect is the same whether the thrombus is primary and the cause of the inflammation, or whether it is secondary, the attack beginning from the outside as periphlebitis.

As soon as the irritation subsides the lymph is in part absorbed and in part converted into fibrous tissue. The thrombus, as already described, may either be absorbed, undergo organization, or decay in the centre and ultimately be canalized. Sometimes the cavity of the vein is restored completely, more frequently it is obliterated for a time, and then subsequently, as the clot is organized or canalized, regains its normal shape and size to a greater or less extent.

**Symptoms.**—When the vein is superficial it can be felt as a hard, knotted cord, standing out under the skin and surrounded by inflamed cellular tissue. It is exceedingly tender to the touch, but, unless the periphlebitis is very acute, and the vein quite under the surface (as in the case of a varicose internal saphena) the skin is seldom much reddened. There is often a very considerable degree of pain and stiffness, especially on movement, or when the limb is allowed to hang down;

and sometimes there is very considerable constitutional disturbance. In the case of the deeper veins the diagnosis chiefly rests upon the deep-seated hardness and tenderness, the peculiarly clumsy appearance of the part, the sense of weight and pain when the limb is allowed to hang down, the relief as soon as it is raised, and the evident distention of the more superficial vessels. Generally a certain amount of superficial œdema can be detected on the distal side of the obstruction, round the malleoli, for example, in cases of phlebitis of the deep veins of the leg.

Gouty, rheumatic, and syphilitic phlebitis can only be distinguished by the other symptoms that accompany these disorders; they have no certain distinctive character of their own, although the gouty variety is occasionally metastatic. They all have a decided tendency to symmetry, they affect the superficial veins rather than the deep ones, and the lower limbs much more frequently than the upper. Recurrence is exceedingly common in the gouty variety, and may continue in the syphilitic form all through the secondary period, but it is seldom that permanent obliteration is caused by either.

**Treatment.**—Rest is absolutely essential until at least all trace of inflammation and tenderness has disappeared. Serious extension of the thrombus and detachment of outlying fragments, causing embolism, are rare accidents, considering the very large number of cases of phlebitis of varicose veins of the leg, but they do happen occasionally, and every precaution must be taken to avoid them.

Elevation is no less essential for the sake of the return circulation and to relieve tension. Cold lead lotion, as a rule, causes the inflammation to subside within a few days; but in cases of gout, and where the arteries are atheromatous, belladonna (equal parts of the extract and glycerine) and warmth should be used instead. The bowels should be kept well open; the diet should be light, without stimulants, and if there is any evidence of gout, rheumatism, or syphilis, appropriate remedies should be employed.

Afterward, when all the inflammation has subsided, the patient may be allowed to get about with a support, and if the leg is much wasted, or has a tendency to remain cold and œdematous, massage may be used to improve the circulation.

### 2. *Suppurative Phlebitis.*

This, too, may originate either as a periphlebitis or in the interior. Example of the former are often seen in diffuse inflammation of the cellular tissue; th pyogenic organisms rapidly destroy the coats of the veins, spreading along th loose cellular tissue round them, and causing them to slough or melt away into th purulent fluid that fills up every interstice. As the endothelium is approache coagulation takes place, and although the thrombus shares the fate of all the re of the structures, fortunately, in the vast majority of cases, it extends sufficientl far and sufficiently rapid to act as a barrier and prevent the poison spreading fa and wide in the circulation. If it fails, or if it is broken down, general pyæmi is almost certain. This is of common occurrence in acute suppurative osteomye litis, and in otitis media, infective inflammation with thrombosis, spreading alon the coats of the veins into larger and larger trunks, until at length the purifor clot that fills the vessel gives way and is scattered all over the body, causin metastatic abscesses wherever it comes.

Acute spreading phlebitis of the same character, and ending in emboli pyæmia in the same way, may begin in the interior of a vein as well as round it This, of course, unless pyæmia has already developed, can only take place afte the cavity of the vein has been opened. Usually, under these circumstances, th vessel either collapses at once or a coagulum forms and extends up to the next se of valves or the next large branch. If, however, septic decomposition sets i before organization has taken place, and lends its aid to the micrococci of suppu ration, the clot melts away at once into an infective puriform fluid, and there i every chance of a widespread distribution of infective emboli all over the body even before the rest of the tissues succumb or the diffuse cellulitis assumes alarm

## SECTION III.—ANEURYSM.

An aneurysm is a circumscribed tumor developed in connection with the interior of an artery, and containing either fluid or coagulated blood.

Aneurysms have been classified in various ways: by their cause (traumatic and idiopathic, or spontaneous); by their shape (fusiform, sacculated, and dissecting), and by the share the wall of the vessel takes in their construction (true and false). Some of these distinctions are very important.

All aneurysms are in a certain sense of the term traumatic, due either to one single sudden strain or to the continued effect of slighter ones; but the term *traumatic aneurysm* is reserved for those cases in which a perfectly healthy artery has been injured in some accident, and either the wall, or the cicatrix, or the coagulum that closed the wound, has expanded into a sac. There is a very great difference in the matter of prognosis and treatment between this variety and the so-called *idiopathic or spontaneous* one, in great measure, if not entirely, the result of disease.

The terms *sacculated* and *fusiform* almost explain themselves; the former is applied to those cases in which a pouch is developed from one side of an artery; the latter to those in which the whole circumference of the artery is stretched more or less. As, for example, in aneurysms of the arch of the aorta, no distinct line can be drawn between the two, or between the latter and what is known as aneurysmal dilatation. *Dissecting aneurysm*, on the other hand, is a very distinct variety; it can only occur in the larger arteries, and results from an early rupture of an atheromatous abscess in the wall. If this occurs before the coats are welded together by inflammatory exudation, the blood may make its way down between the layers of the wall for long distances, and ultimately break either into the interior again or outside. In the former case it may give rise, for a short distance, to the appearance of a double aorta.

Aneurysms used to be described as true, when all the coats of the artery were to be traced in the wall, or, according to others, when one of them could be. This, of course, is only possible when the aneurysm is fusiform in shape or exceedingly small in size, and the distinction is not worth maintaining.

An aneurysm sometimes ruptures, suddenly or gradually, producing the same effect as if the artery had given way—an arterial hæmatoma. A diffuse aneurysm is a contradiction.

### Idiopathic or Spontaneous Aneurysm.

Idiopathic aneurysm is due to the yielding of a weakened part of a vessel under the influence of the blood-pressure.

**Causes.**—(*a*) All forms of inflammation predispose to aneurysm by the way in which they weaken the wall of the vessel. *Atheroma* is the most common, especially in its earlier stages, when the muscular coat is infiltrated with lymph and weakened, without as yet any considerable degree of degeneration. If at a later period the floor of one of the ulcers yields and gives way, the adventitia is usually sufficiently thickened by that time to render it secure. Dissecting aneurysm must, of course, be due to atheroma. *Embolism* is not infrequent, especially in young subjects, not because of the obstruction it causes (for then aneurysm would frequently follow ligature), but owing to the softening and inflammation of the vessel at the injured spot. In other cases it is a form of *peri-arteritis*, either syphilitic, as in the vessels at the base of the brain, or suppurative, when, for example, small aneurysms form on branches of the pulmonary artery in the wall of phthisical cavities.

(*b*) Injury acts both as a predisposing and an exciting cause. Its effects are best seen in the case of the popliteal, the inner and middle coats of which, even when it is healthy, may be ruptured by over-extension of the knee. Probably one reason why aneurysms are so common in this artery is that even when this does not take place, the walls are easily injured in the constant and violent flexion and extension to which they are subjected. In a few instances an aneurysm has developed in an artery that has been subjected to long-continued compression.

(*c*) The immediate cause is the blood-pressure. If the coats of an artery are weakened by injury or inflammation, they gradually yield before it, especially if it is raised by hypertrophy of the left ventricle, Bright's disease, chronic alcoholism, plethora, or other causes. In many instances the first commencement of an aneurysm is traced to some sudden exertion, which either, as in the popliteal, directly ruptures one or more of the coats of the vessel by over-extension, or produces practically the same result by the immense increase in the blood pressure that attends sudden and violent muscular efforts.

This serves to explain why aneurysms are so much more common in men than in women (with the exception of those of the carotid, which are equally frequent in both), and particularly among those who are exposed to sudden strains. Further, it gives a satisfactory reason for the extreme frequency with which the popliteal artery and the arch of the aorta suffer in comparison with others.

Aneurysms are most common between thirty and fifty years of age, when the arteries are diseased, and the heart and the muscular system have not lost their vigor. Soldiers and sailors are especially liable to them, partly from their occupation, partly, perhaps, because of syphilis, although the share that this takes in the development of aneurysm is probably not a large one.

[The influence of climate is a constant but as yet imperfectly understood factor in the production of aneurysm.]

**Mode of Formation.**—Fusiform and dissecting aneurysms are only met with in connection with the largest arteries. The former are caused by a uniform expansion of all the coats, so that the cavity of the vessel is increased in diameter and somewhat lengthened. The outer coat usually becomes thickened and strengthened by the addition of fibrous tissue formed from the lymph that is poured out in its interstices; the inner may be unaltered, although it is usually in a more or less advanced stage of atheroma; while the middle always degenerates, the muscular fibres becoming further and further separated from each other and ultimately disappearing altogether. Dissecting aneurysm, which, singularly enough, is more common in women than in men, is rare at all times, and is only met with in the aorta.

Sacculated aneurysm may arise by itself from the side of a vessel, or as a further development from a weakened spot in the wall of a fusiform one. So long as it is small, the adventitia, thickened and more densely fibrous than elsewhere, can be traced over it, and it may appear to be still lined with intima; but even in small ones the middle coat is wanting, and in those of moderate size, and still more in large ones, no distinction of coats can be made out in any part. The sac-wall is formed of fibrous tissue, partly the product of inflammation excited by the constant pressure, partly the residue of the structures which it has displaced, turned on one side, and caused to atrophy. Even bone and cartilage waste away before an aneurysm, but as they resist longer than most other structures, portions of them are occasionally found in the wall, projecting into the sac. The lining membrane may be smooth and shining, or covered with calcareous plates and irregular from atheroma, but it cannot be separated from the fibrous wall.

Fusiform aneurysms rarely contain any clot, or, at the most, a small thrombus formed upon a projecting calcareous plate. Sacculated ones, on the other hand, are seldom quite empty and may be completely filled. It varies in character and appearance, according to its age, and whether it has been formed from stagnant or circulating blood. The oldest part, that which lines the sac wall, is hard, dense, and yellowish-white; inside this are generally many layers, more or less coherent,

some colored and others not, but less firm; and inside these again very often a loose, soft, and recent coagulum. No sharp distinction can be drawn between them, although the extremes are exceedingly different. The one is known as *laminated* or *active* clot, containing very few red corpuscles. As the blood whirls round in the interior the platelets are whipped out from it and deposited upon the irregularities of the surface until they are welded together into a coherent mass by the fibrin that they form. This is repeated again and again, and layer after layer is thrown down, some quite colorless, others, when the circulation is slower, containing a few red corpuscles, until in successful cases the whole interior is filled. Even when this does not happen the wall is rendered immensely stronger wherever the layers are formed, and as the size of the cavity diminishes the expansive power of the blood pressure diminishes too.

The loose red coagulum formed from stagnant blood is called in distinction *passive*. Its behavior is always very uncertain; sometimes it melts away and disappears, so that an aneurysm that felt quite solid one day may the next pulsate as strongly as ever; sometimes, on the other hand, it shrinks and becomes organized, or under the impact of the blood stream is flattened out into a colored lamina. It is not, therefore, so useless as its name implies. The future destiny of the laminated clot cannot be regarded as certain. The white corpuscles it contains undergo fatty degeneration and the longer it lasts the thinner and harder it becomes, until at length in old cases it disappears altogether, probably undergoing fatty transformation and absorption. There is no proof that it becomes organized, its density is too great.

Sacculated aneurysms may attain an enormous size; not unfrequently more than one is present, and in any case the heart and every artery in the body that is accessible should be carefully examined before the treatment is determined.

**Symptoms.**—The first appearance of an aneurysm is a soft, elastic, circumscribed, and pulsating swelling in the course of one of the large arteries. Its features vary according to the amount of clot it contains. At first it is filled with fluid blood, but by degrees, as fibrin is deposited, it becomes firmer and harder, until at length in some cases it is absolutely solid, and presents all the characters of a solid growth. The pulsation varies in the same way. So long as the contents are fluid and the cavity communicates directly with an artery, this is characteristic; the sac becomes tense with each beat of the heart and expands in all directions; it is not merely the lifting up and falling down of the mass, as when a solid growth rests upon the wall of a vessel, it is an *expansile pulsation*, and this peculiarity can usually be recognized at once by placing the fingers one on either side of it, or one above and the other below. As, however, it becomes solid this is lost. At first there may be some pulsation communicated to the tumor from its resting upon the artery; but even this, when the vessel is thrombosed, disappears, and it remains perfectly motionless.

The difference in the tension, which is no less marked a feature, depends upon the same cause. If the limb is raised, the artery contracts, and so long as the contents are fluid the pulsation and the tension in the sac diminish; if it is allowed to hang down, the effect is just the reverse. If the artery is compressed upon the cardiac side the pulsation ceases, the tumor shrinks in size, and may even become perfectly empty and collapse. When the finger is raised, it fills again in two or three beats, expanding forcibly in all directions.

In nearly all cases, so long as the blood circulates through the cavity, a bruit is heard all over the tumor, synchronous with the beat of the heart, and very often a thrill is felt. These, of course, vary very greatly, not only in different cases, but at different times in the same, as they depend upon the position of the orifice and the amount and situation of the laminated clot deposited inside. Care must be taken in investigating this not to compress the artery against a subjacent bone, as a distinct bruit can be caused in this way even when the vessel is perfectly healthy.

In internal aneurysm, on the other hand, or where the tumor is inaccessible,

these signs may be wanting altogether, and then the diagnosis must be made partly from the effect upon the pulse, partly from the pressure symptoms.

The pulse in the parts below is always modified, the force of the heart is lost in stretching the sac, and little or none of this is returned, owing to the absence of elastic recoil. If the aneurysm is a large one, especially if it is near the centre of the circulation, compensative hypertrophy of the left ventricle sets in; if it is further away the collateral circulation enlarges, but in any case the pulse below is wanting in strength, the sphygmographic tracing shows the wave is lower and less marked, and the tissues beyond are ill supplied with blood. In some instances the wasting and loss of strength produced in this way are very characteristic.

An aneurysm, by its immense and constantly varying pressure, always causes a certain degree of inflammation in the tissues around. In most cases this is merely sufficient to develop the fibrous capsule, but sometimes, especially in the axilla and the groin, where the enlargement is very rapid, suppuration sets in, and the whole sac sloughs out. In addition, it often gives rise to very important signs by the way in which it interferes with the structures near it. Bones are absorbed, being hollowed out or perforated, as in the case of the sternum, without of necessity a trace of inflammation; cartilages are treated in the same way, although they resist longer; muscles become reduced to flattened, fibrous bands; veins are obliterated; nerves stretched and expanded into ribands, and in certain situations other organs, such as the œsophagus, trachea, or thoracic duct, compressed and prevented from working. The symptoms caused in this way are naturally of the most varied character. Intense neuralgic pain, referred to the distribution of the nerves and worse at night, is one of the most common; spasmodic contraction, paralysis, wasting, hyperæsthesia, and alteration in the electric reaction may occur. The sympathetic in the neck may be pressed upon, causing vaso-motor and pupillary changes. The recurrent laryngeal may be paralyzed, giving rise to a peculiar and most significant tone of cough. There may be the most intense pain from pressure upon the cords of the brachial plexus. In short, there is scarcely a symptom due to nerve irritation or compression that does not occur sometimes in connection with aneurysm. Immense congestion, with dilatation of the veins, œdema, and even moist gangrene may be caused by pressure upon one of the great venous trunks. Dyspnœa and dysphagia may occur from partial occlusion of the trachea or œsophagus. And even in some very rare cases the artery itself may be so compressed by the aneurysm springing from it as to cut off the circulation through it, and so effect a permanent cure.

**Progress and Termination.**—Aneurysms, especially fusiform ones, that partake rather of the character of aneurysmal dilatation, and those which occur in old people who lead quiet lives, occasionally last for many years unchanged. This, however, is exceptional; as a rule, if left to themselves they either undergo spontaneous cure or prove fatal from rupture of the sac, suppuration, pressure upon some important organ, or, especially in the case of large thoracic ones, syncope.

1. *Spontaneous* cure may be produced in various ways.

(*a*) The sac may gradually be filled with laminated clot, until at length the artery itself is occluded, or there is merely a narrow channel left, running down through the centre of the tumor. A certain amount of active clot is present in all cases of sacculated aneurysm, forming, as it were, in the eddies of the blood-stream if this is diverted from time to time into different directions, so as to fill up one part after another, or if the circulation through it is rendered very slow and uniform by some accident, such as the development of the collateral circulation the pressure of the aneurysm upon the artery above, or the formation of a fresh aneurysm upon the same trunk higher up, it sometimes happens that the whole sac is obliterated and cure effected (Fig. 52).

When this occurs the tumor becomes smaller and harder, the characteristic expansile pulsation ceases, although, so long as the artery is unobliterated it may be lifted up and down with each beat, and the bruit and thrill disappear. At the same time the collateral vessels can sometimes be detected; and not unfrequently

their enlargement is attended with a certain amount of aching pain. Finally, the whole sac shrinks to a small, hard nodule, sessile upon the artery.

(*b*) The distal orifice of the sac may be suddenly plugged by a detached fragment of clot. In this case the aneurysm rapidly becomes filled with stagnant blood, which coagulates, forming a loose, soft clot, and then gradually shrinks under the pressure exerted upon it by the displaced tissues around. If the coagulum extends into the orifice of the artery, the cure is likely to be permanent, organization taking place in that part of the recent clot which is in contact with the intima of the vessel, the rest being ultimately absorbed.

Rapid cure of this kind is usually attended with a severe degree of pain for a short time, the limb feeling exceedingly tense and full, and the part beyond cold and numbed. Ultimately the collateral circulation enlarges and the sac shrinks up as before.

(*c*) Suppuration may occur. The loose cellular tissue round the sac becomes more and more inflamed; the outline of the tumor disappears; the skin over it becomes hot, red, and œdematous; the size of the part increases rapidly; there is

*a*. The cut edge of the arterial coats where healthy.

*aa*. The coats in the diseased and occluded part of the artery. Their substance is dispersed and blended with the new fibrous tissue, *b*, which fills the vessel, yet not so much diffused but that they can still be traced to the mouth of the aneurysm (opposite the upper *c*).

*c*. The aneurysm sac, composed of laminated clot and compressed tissue welded together indefinitely.

*d*. Scarcely laminated clot, filling the hollow of the sac.

The vein, with two valves in its lower part, is seen close behind the artery.

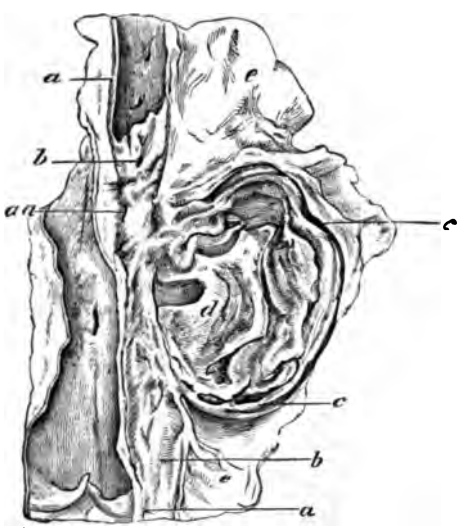


FIG. 52.—Section through an Aneurysm of the Popliteal Artery, Cured nearly two years before by Digital Pressure. The aneurysm is not dissected out, but left embedded in the popliteal fat, *e*, *e*. The artery is occluded with the aneurysm.

intense, throbbing pain, with high fever, and then suddenly the skin gives way over it, and pus mixed with sloughing shreds of fibrin, chocolate-colored masses of the broken-down blood-clot, and perhaps fresh arterial blood, pours out. Suppuration has taken place round the aneurysm and it has sloughed. If the walls of the artery above and below have been able to resist the action of the pyogenic micrococci, and form and organize a thrombus in their interior, hemorrhage may never occur and the cure may be permanent; if, on the other hand, as too frequently happens under these circumstances, the nutrition of the tissue fails, organization lags behind, the clot softens and melts away under the influence of the blood-pressure, and the gush of arterial blood may prove instantaneously fatal.

2. *Enlargement.*—The pressure in the interior of an aneurysm increases in proportion to its cubic contents. Partly for this reason, partly, perhaps, because after a certain time the tissues round it resist less well, it is not uncommon to find, after it has reached a certain size, that the rate of growth becomes much more rapid and the wall exceedingly thin. In these circumstances, if it does not prove fatal from syncope, suppuration, or pressure upon some organ essential to life, rupture occurs sooner or later.

The way in which this takes place and the symptoms to which it gives rise vary with the situation. Hemorrhage into a serous sac is usually rapidly fatal, a great stellate opening forming and admitting a full rush of blood. When it occurs on a mucous surface, on the other hand, days may pass before the final outburst, the orifice being very minute and becoming plugged with a coagulum which only allows a certain amount of leakage from time to time. Rupture on the cutaneous surface is still more rare, unless preceded by inflammation and suppuration. The tumor may render the skin red, tense, and shining, or may even raise the epidermis up in the form of a blister, so that bloody serum soaks through and forms a scab on the surface; but unless suppuration occurs, or a slough is formed, external hemorrhage is, comparatively speaking, a rare form of death. In the majority of cases of rupture the sac gives way subcutaneously, and the blood is extravasated into the cellular tissue. A small amount usually escapes at first, causing some increase in the size of the tumor, then it coagulates and forms a wall around itself. After this it may remain quiet for several days, or may cause suppuration, or may, in very exceptional instances, lead to the development of a new and stronger sac. More frequently it is only the prelude to a more extensive hemorrhage which pours in all directions into the cellular tissue around, causing the most intense pain, and leading to complete cessation of the circulation in all the parts below. The patient may faint at once and become collapsed, partly from the loss of blood, partly from the shock and pain; the limb beyond becomes cold, œdematous, and pulseless; the region of the aneurysm is immensely distended; all bruit and pulsation disappear, and if speedy steps are not taken moist gangrene is inevitable. An aneurysm that is enlarging very rapidly, especially in one direction, is sometimes described as leaking; either the sac has already given way, or it is in imminent danger of doing so, and there is the greatest risk that actual rupture, which in an aneurysm of any size is hopeless so far as the limb is concerned, and always places life in very serious jeopardy, may occur at any moment.

In the case of ruptured popliteal aneurysm, the appearance of the limb is not unlike that produced by deep-seated suppuration; the skin all round the back of the joint is red, tense, and œdematous on pressure, and the pain is most acute and throbbing, and the history may be that of a rapidly forming abscess; but the cessation of the circulation in the limb below, the coldness and œdema of the part, and the loss of sensibility in the toes, point unmistakably to some grave interruption in the blood-supply. Moist gangrene in such cases is inevitable.

**Diagnosis.**—1. In its earlier stages, while it still pulsates.

(*a*) Aneurysm may occasionally be confounded with a form of aneurysmal dilatation chiefly met with in the innominate and the abdominal aorta in young women. The dilatation and the pulsation are often exceedingly well-marked, but the age and sex, the effects of tonics, especially iron, and the evidence of other nerve troubles are usually sufficient to make the diagnosis certain at once. As the dilatation disappears again completely there can be no serious morbid lesion in the wall of the vessel.

(*b*) Fluid tumors, bursæ, hydatid and other cysts, and chronic abscesses in the neighborhood of large arteries or on their walls occasionally present great difficulty. If, however, they pulsate they do not expand in the way that an aneurysm does, and though they contain fluid they cannot be even partially emptied by pressure upon them. A bruit or thrill is exceptional, though it may be produced if the artery is compressed or bent irregularly.

(*c*) Pulsating sarcomata are usually found in early life or in localities in which aneurysm is either very rare or practically unknown, and even when they do grow from such places as the back of the knee joint the diagnosis is seldom difficult. The pulsation is not expansile; the bruit, when there is one, can only be heard over a limited area; the tumor cannot be emptied either by direct pressure or by compression of the artery above, and even if it can be reduced in size, it refills slowly, not with the rapid bound of an empty aneurysmal sac. In some instances, however, when the tumor is intra-pelvic, a positive statement is often im-

possible without examining the case more than once and watching the manner of its growth.

2. Aneurysms that do not pulsate, whether this arises from their being already filled with laminated clot or from some peculiar anatomical relation to the artery from which they spring, are exceedingly difficult. All the ordinary signs fail completely, there is no pulsation or bruit, the tumor cannot be emptied, it lies in the region of an artery, but it cannot be separated from it or lifted off it. In short, in all such a most guarded opinion must be given until the case has been watched some little time. If it is a cured aneurysm it will slowly tend to become smaller and smaller; if it is not cured, but merely prevented pulsating by some accidental condition, it will either cure itself or some day pulsation will suddenly make its appearance.

3. Ruptured and suppurating aneurysms can usually be recognized by the complete and sudden obstruction to the circulation in the part below. Even if no history can be obtained, the coldness of the distal portions, the œdema, numbness, and cessation of the pulse, should at once arouse suspicion. In any case of doubt the introduction of a grooved needle can do no harm, but both the patient and the operator must be prepared for any measure that is necessary. Suppuration may be distinguished from simple rupture by the intensity of the local signs of inflammation.

**Treatment.**—Aneurysms may be treated in many different ways, according to the conditions under which they are placed, but the idea is the same in all, to bring about one or other of those changes by which spontaneous cure is effected, viz., the deposit of laminated clot, the rapid coagulation of the contents of the sac, or the exclusion of the aneurysm from the circulation, as in suppuration.

### I. *The Deposit of Laminated Clot.*

This may be accomplished either by increasing the amount of fibrin in the blood, or by rendering the circulation through the sac as slow and as uniform as possible. Of these two the first is at present entirely beyond our power; nothing is known that can increase or diminish the amount of fibrin without at the same time causing even more serious changes, and it must be remembered that an increase in the quantity of fibrin is not the same thing as increasing the readiness to coagulate.

The circulation through the sac may be controlled by constitutional or local measures, or by both together.

(*a*) ***Constitutional Treatment.***—Rest, in the recumbent position, is of the utmost importance; it lessens the force of the heart-beat, reduces its frequency, and keeps it uniform. The sudden enlargement of an aneurysmal sac can often be traced directly to some comparatively trivial exertion.

The diet must be restricted. In many instances it is of advantage to adopt Tufnell's system. The patient is placed on a well-made hair mattress, with a water cushion, and forbidden to raise hand or foot for any reason. The diet is reduced to eight ounces of solids and six of fluids per diem (six ounces of bread with a little butter, two of meat, and six of milk), and is maintained at this level for some weeks. The patient, of course, becomes extremely emaciated and feeble (it is necessary to take great care that he does not catch cold), but the number of heart-beats can be reduced to forty-two or forty-four in the minute; and not unfrequently it happens while this is going on that, owing to the slowness of the current in the aneurysm, many fresh layers are deposited on its wall. Moreover, the improvement is not only maintained, but often becomes much more marked when the diet is gradually raised again. In patients who are feeble and anæmic already, this, of course, is not advisable. Not unfrequently with them a more generous diet, combined with iron, reduces the frequency of the heart-beat, although it may somewhat increase the force; stimulants, however, should always be avoided.

The bowels must be kept well open; if the arterial tension is high, repeated

saline purges are recommended, and even venesection. Opium is of great use in controlling pain and procuring sleep. Other drugs are recommended from time to time, but it is difficult to show that any improvement that takes place during their administration is actually the result of their influence. Iodide of potash, for example, has a distinct effect upon the blood-pressure, and relieves the nocturnal bone-pain so common in some forms of internal aneurysm, and, moreover, is sometimes of benefit when there is a decided history of syphilis; but it certainly tends to diminish the coagulability of the blood. [Post-mortem dissection has shown the consolidation of the contents of the aneurysmal sac too frequently to admit of a doubt that potassium iodide does exercise a materially curative effect on the larger aneurysms.] Digitalis may modify the action of the heart, but it also tends to raise the arterial pressure. Aconite and belladonna may be given with better reason. There is no proof that either ergot or acetate of lead has the least effect.

(*b*) *Local Treatment.*—The simplest method is to raise the part if it is one of the limbs, bandage it, and apply gentle pressure over the tumor. This, however, is rarely enough, except in the case of the anterior tibial or other small vessels. Sometimes these are injured in fractures, and then an aneurysm may develop and be cured while the patient is lying in bed with his limb in splints. Whatever method is finally adopted, bandaging and elevation always form part.

1. *Compression of the Main Artery on the Cardiac Side.*—This may be digital or instrumental; in either case the object is to diminish the stream of blood flowing through, so that the fibrin may be deposited on the walls. It is not necessary to occlude the artery completely, all that is required is to prevent pulsation in the sac; and this is especially to be remembered, as many cases in which this plan has failed have been given up because the patient would no longer stand the pain, and in one or two inflammation of the wall has been caused, and a second aneurysm has developed later on.

The patient must be placed in a comfortable position, and the skin shaved and powdered well with French chalk. Digital compression is to be preferred wherever it is possible, but it can only be carried out where the artery is superficial and rests against a bone, as in the case of the femoral at Poupart's ligament, and at least three people are required. Two fingers should be placed upon the vessel, care being taken not to include the vein, and a weight of about four pounds (suspended by a pulley from somewhere overhead) allowed to come down and rest upon the dorsum of the last two phalanges. Pressure, carried out simply by muscular exertion, is exceedingly exhausting, and can only be kept up for a short time. With the aid of a weight it can be maintained with perfect uniformity for half an hour without changing and without fatigue. When a change is made, the vessel should be secured above or below with the other hand, so that no pulsation can take place in the aneurysm, and the grasp should not be relaxed until the new-comer is certain that he has secured the vessel. One hand should be kept upon the aneurysm the whole time, to make sure that there is no pulsation. The number of hours this treatment has to be maintained depends a great deal upon the thoroughness with which it is carried out. Usually compression is continuous for the first twelve or fifteen hours. If the tumor becomes solid in that time it is probably filled to some extent with laminated fibrin, but much more with recent soft coagulum, and the limb must be elevated and firmly bandaged with a compress over the whole length of the artery for twenty-four hours more, for fear of the contents being washed out again. At the end of that time it is fairly safe, although no precaution may be relaxed until the tumor has begun to diminish distinctly. If no change is detected, it should be left for a few days and simply bandaged; perhaps at the end of that time a certain amount of fibrin will have been laid down and it is certainly better to allow the patient time to rest. Even when every precaution is taken continuous compression becomes very painful, especially if there are any enlarged glands round or near the vessel. At the end of a week a second attempt may be made, following the same plan, or shorter sittings may be tried for four or six

hours a day, until the cure is complete. When this is successful, the fibrin is deposited in laminæ, but it may be a week before there is any distinct solidification. If it has been tried well and it does not succeed at the end of that time it should be given up.

Instrumental compression is carried out on the same plan, chiefly with Carte's tourniquet, which has the advantage over others of greater elasticity of pressure and of a double pad, so that the point of compression can be varied without moving the instrument. In some parts of the body (the abdominal aorta, for example) only instrumental compression is possible; but in most, if it can be managed, the digital plan is to be preferred as less likely to injure the artery and more easy to adjust.

Opium is not unfrequently required to allay irritability and to procure sleep. Sometimes, as in the case of the abdominal aorta, an anæsthetic is necessary. If compression fails or the patient will stand it no longer, the artery must be tied, but not at the spot at which it has been compressed, for in all probability the coats of the vessel are somewhat thickened there, and perhaps matted together by adhesive inflammation. It appears from statistics that ligature after compression is not so favorable as immediate ligature—what this may be due to is not certain; there is no doubt that the collateral circulation enlarges from the effect of continued pressure, and that this, while it checks the tendency to gangrene, at the same time maintains, perhaps too well, the current through the sac; but it must be remembered that the cases are not like fresh ones, they have already failed once.

Compression is the plan of widest and most general application; it avoids the necessity for a wound and the risk of secondary hemorrhage; but it can only be employed in certain cases (fortunately, the majority); it must never be used where, from the presence of œdema or venous engorgement, there is reason to fear obstruction to or pressure upon the main vein of a limb, or where the sac is enlarging rapidly and in danger of rupture; and it must be admitted that sometimes, perhaps from want of intelligence on the part of the patient, it is exceedingly difficult to carry out thoroughly.

2. *Ligature of the Artery on the Cardiac Side, at a Distance from the Aneurysm; the Hunterian Operation.*—The object is to allow a slow stream of blood to flow through the sac and deposit layers of fibrin upon the walls, not to cut off the circulation completely, and fill the cavity with a loose, soft coagulum. Additional advantages of ligature at a distance from the sac over ligature close to it are that the operation is easier, the best part of the vessel being selected; that the artery is much more likely to be healthy; that the sac is less interfered with, so that there is less risk of suppuration; and that the collateral circulation is likely to be better, and the danger of gangrene less.

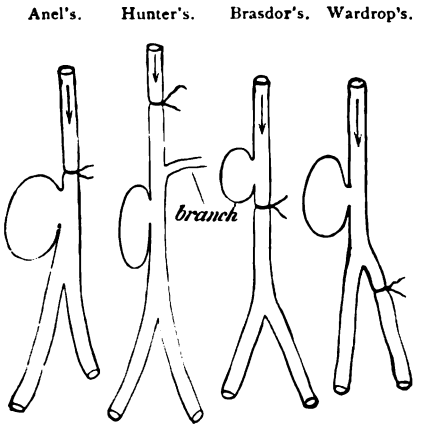


FIG. 53.—Diagram Showing the Different Operations for Aneurysm.

The immediate effect of tightening the ligature is to stop the pulsation in the aneurysm. The blood pressure begins to fall at once, the tissues around resume their normal position, the tumor diminishes in size, and its outline becomes less distinct. In most cases, however, especially when compression has been tried before ligature, and the collateral circulation is already established, coagulation does not take place at once; the current is not shut off completely; from the first it flows through in a gentle, continuous stream, and under its influence fibrin is deposited in layers on the wall until the sac is filled and the artery blocked above and below. In some cases slight but distinct

pulsation can b
days after the

ends of the artery may become sealed, and turning out all the clots would only increase the chance of hemorrhage by opening them up again. If, however, pulsation continues, there is no hope but in amputation, plugging, or placing a tourniquet upon the artery higher up, laying the whole open from one end to the other, turning out all the sloughs and broken-down clot, and securing everything that bleeds as far from the surface of the wound as possible. Afterward, and in any case, watch must be kept night and day until the wound is healed.

3. *Distal Ligature after Wardrop's Method.*—This is ordinarily classed with Brasdor's, and as a matter of history was a deduction from it, but there is an essential difference between them. In Brasdor's the whole circulation is cut off, the aneurysm is left full of clot, and complete obliteration is aimed at. In Wardrop's the whole circulation is not cut off, large branches are left either between the seat of ligature and the aneurysm or arising from the sac itself; and these branches begin at once to increase in size, so that whatever benefit is derived from the operation, and in some instances it has been shown to be very considerable, it cannot be due to immediate obliteration of the cavity.

As a matter of practice it is reserved almost entirely for aneurysms at the root of the neck, whether springing from the subclavian, innominate, or aorta. The benefit some of those springing from the arch itself have derived is very remarkable, although in some of the earlier cases the operation was performed under the erroneous impression that the innominate was concerned. As at first practiced, the carotid and subclavian were ligatured simultaneously with a view of diminishing the amount of blood flowing through; but that this cannot be the correct explanation is clear from the fact that in some cases as much benefit has been derived from ligature of the left carotid only. The result must be due either to a coagulum projecting back into the sac, and acting as a nucleus for the deposit of laminated fibrin, or to the fact that the direction of the stream is changed and the pressure transferred to parts which not only have not been so much weakened, but which even may have been strengthened by the deposit of fibrin upon them while they were lying out of the direct flow. Possibly there is something to be said for both views.

II. *Rapid Coagulation of the Contents, such as is produced naturally when an embolus is dislodged and blocks the distal orifice.*

The natural method of cure may be imitated in many ways, with varying success; but with the exception of one (the use of Esmarch's bandage) it is only employed under special conditions when ligature or compression is out of the question. Constitutional treatment must, of course, be maintained at the same time.

1. *Esmarch's Bandage* (*Reid's Method*).—The aneurysm is filled with blood and the circulation arrested above and below.

An elastic bandage is applied to the distal part of the limb, either beginning at the end and carrying it up to the sac or leaving the fingers or toes, as the case may be, and commencing only a short distance below. The sac is then allowed to fill, the bandage either carried over it very lightly or made to skip it altogether, and applied firmly again to the part above. If there is not sufficient room, an elastic strap may be used, or an abdominal tourniquet, as the case requires. The bandage is usually applied for about two hours (I have known half an hour successful, but this was a very exceptional case) and then digital or instrumental compression kept up on the trunk above for twelve hours more, in order to protect the clot at the entrance of the vessel from the impact of the blood.

In a successful case the whole of the sac is filled with a coagulum which extends into the artery and occludes it. The hope is that this, if not displaced, will become organized where it is in contact with the intima, and be replaced by fibrous tissue; while the rest of the coagulated blood, lying out of the current, will either be absorbed or dry up. Possibly it may become organized too.

An anæsthetic is absolutely necessary the whole time, as the proceeding is very

painful. If the aneurysm is on one of the limbs, this should be raised and ca fully wrapped with cotton-wool before the constriction is removed.

The chief advantages of this method are its simplicity and rapidity. It su ceeds best, naturally, with small aneurysms in young subjects free from cardi disease or extensive atheroma, and should not be used for large ones or those the point of rupture. At the same time it is practically the only plan admissib for some aneurysms of the abdominal aorta and its branches.

Failure is not infrequent, the aneurysm appearing perfectly solid when t bandage is unwound, but becoming completely empty by the next day in spite the precaution of pressure upon the supplying trunk. If this happens once it nearly sure to happen a second and a third time. If, on the other hand, the coa ulum remains firm for twenty-four hours the cure is likely to be permanent.

A considerable amount of ecchymosis is often noticed round the sac, but does not appear that there is any unusual danger of gangrene. The bandage h been kept on for upward of three hours and a half in a case of popliteal aneurys without any ill effect. Rupture has occurred on one or two occasions from t tension to which the sac has been subjected, and there is always the possibility, there is any cardiac disease or atheroma of neighboring vessels, of throwing t great a strain upon them, but, provided the cases are carefully selected, it is safe as any other method.

Where it is possible the elastic strap tourniquet should be avoided, and tw or three turns of a broad rubber bandage made round the part instead ; the sha construction of a rubber band has before now caused paralysis of a nerve by co pressing it against a subjacent bone.

The other methods for obtaining rapid coagulation are of very limited app cation.

2. *Manipulation.*—An attempt is made to detach some of the clot from t interior, and plug the distal orifice with the embolus, as in the natural metho The artery should be compressed upon the cardiac side during the manipulatio This has succeeded in a few instances in which there was practically no alternativ but it should never be tried at the root of the neck if there is the least suspici that the carotid is involved.

3. *Flexion.*—Aneurysms at the knee and elbow may be compressed, and pulsation stopped by extreme flexion of the joint, but the process is painful, certain, and only advisable under special circumstances, when, for example, pul tion has returned after ligature. The limb must be bandaged as high as aneurysm, flexed until pulsation ceases, and then fixed for some hours, the pati meanwhile being kept under the influence of morphia. Afterward the same p caution must be adopted as in Reid's method.

4. *Brasdor's Operation or Distal Ligature of Trunk without Leaving any In vening Branch.*—This is only possible in aneurysm of the root of the common ca tid, all other large arteries having too many branches. The cavity is filled at once in embolism, but the blood-pressure soon falls ; the tissues around expand aga the sac diminishes in size, and the blood that it contains probably coagulates once. Sometimes the coagulum extends down into it from the seat of ligatu For aneurysms in that particular situation it is exceedingly suitable.

5. *Distal compression* has been tried in imitation, but, except in a few eurysms of the abdominal aorta, it is of very little service. It throws the wh strain upon the sac without anything like the same certainty of coagulation.

6. *Introduction of Foreign Bodies into the Sac.*—Of these, iron wire seems afford the best prospect. As yet it has only been used in desperate cases of int nal aneurysm, so that it must not be judged too harshly. In one or two it been partially successful, but in spite of this it cannot be recommended until other methods have been exhausted.

The wire must be sufficiently fine and flexible to coil up in the interior of sac without exerting any degree of internal pressure ; and especial care must taken to bury the ends as effectually as possible. Usually it is passed in throu

one of Southey's trocars, the puncture being sealed with strong carbolic acid or the actual cautery. In the most successful case (Loreta's, one of abdominal aneurysm, in which the sac became consolidated and the patient lived for 92 days afterward) only six feet were employed, and probably in some of the first the amount was unnecessarily great. Undoubtedly it causes coagulation of the blood, but the result is usually fatal from rupture of the sac at some weak spot, or from inflammation set up by the necessary manipulation.

It has been proposed to connect the wire with the positive pole of a battery and pass a continuous current through; but coagulation, in all the cases yet recorded, appears to have been induced with sufficient rapidity without this.

7. *Galvano-puncture.*—Coagulation may be started in the interior of an aneurysm by means of galvano-puncture, provided the part of the wall selected is not too thin, or the sac extending too rapidly; and possibly the clot so formed may change the direction of the stream and lead to the deposit of fresh layers over the weaker parts. The difficulty is that, especially in the case of thoracic aneurysms, for which this is chiefly used, it is almost impossible to form a definite idea as to the size of the orifice of communication, the direction in which the aneurysm is spreading, or the course of the blood-stream through it. Still, in some cases of sacculated aneurysm springing from the arch of the aorta, a very decided improvement has been effected with very small risk. Unhappily, accumulation of fibrin on the front of the sac (often the only part accessible) may be attended with, or may actually cause, rapid extension in some other direction, unknown and unsuspected.

Fine trocar-shaped needles are the best, insulated up to the neck with vulcanite; silk causes too much irritation, and sealing-wax or simple rubber does not adhere sufficiently. They are attached to the positive pole only; the negative, which should never be introduced into the sac, is connected with a large zinc plate, covered with wash-leather and soaked in salt solution. The patient can rest his hand on this and interrupt the current at any moment; but as the strength never should exceed five or six milliampères, there is no pain or shock to cause any alarm even when the aneurysm is close to the heart. Two or more needles are introduced parallel to each other, well into the interior, until their external ends distinctly vibrate; then the current is turned on and continued until the movement ceases and the tissues around feel hard. The needles should be left in for an hour or so afterward, in order that the clot may attain some degree of firmness and become fixed. Nothing, or at most a little blood-stained serum, exudes from the punctures, but it is as well to cover them with collodion. By repeated applications of this kind, I have succeeded in keeping in check an aneurysm of the aorta that had already caused partial absorption of the sternum, and with such success that for some time the pulsation disappeared from the intercostal spaces. Unhappily, sudden excitement one day caused a rapid extension of the tumor, and the skin became so much stretched and thinned that nothing further could be done.

8. *Acupuncture.*—In one or two cases, this has been tried with at least temporary benefit. Three pairs of long, fine darning-needles were introduced into the sac, so that each pair crossed in the cavity. They were left in for five days, by which time they had caused a considerable degree of clotting; and this gradually increased until at length the sac became almost solid.

### III. *Exclusion of the Aneurysm.*

This takes place when suppuration occurs round an aneurysm and the sac sloughs out. What is known as the old operation is carried out on the same plan; a free incision is made into the sac, all the clots turned out, and the artery tied above and below. With the aid of tourniquets, the primary hemorrhage can be fairly well controlled; but as the artery in idiopathic or spontaneous aneurysm is almost certain to be extensively diseased on either side, the risk of secondary

hemorrhage is very great; and even if this does not occur, gangrene is exceedingly likely to follow. Practically it is reserved for traumatic aneurysm, embolic aneurysm of the upper limb in young people, and cases in which, after ligature of the artery, the sac has become inflamed and is beginning to suppurate, without the pulsation having ceased.

### IV. *Amputation.*

This may be required if moist gangrene sets in; for rupture of the sac; suppuration with threatened hemorrhage; or disease of a neighboring bone or joint. If secondary hemorrhage occurs from the seat of ligature, an attempt may be made to secure the two ends of the artery *in situ;* but if it is clear that the walls of the vessels are seriously diseased, it is probable that amputation at once, if it is practicable, gives the patient a better chance of life.

## Traumatic Aneurysm.

The formation of traumatic aneurysm has been already described; an artery is injured and the cicatrix yields; or one of the coats is torn through, and the others are unable to stand the strain; or there is a wound plugged with a coagulum which gradually stretches under the influence of the blood-pressure; in any case a circumscribed sac containing fluid blood forms in connection with the interior of the vessel and grows larger and larger, the wall, as soon it attains any considerable size, being formed of fibrous tissue thrown out by the inflamed and irritated structures around, and lined with laminated clot.

Its progress and terminations are similar in all respects to the idiopathic form; it may become filled with laminated fibrin, or with loose soft blood-clot; it may cause suppuration around; it may leak by slow degrees and then suddenly rupture into the cellular tissue; sometimes even it forms a communication with a vein (arterio-venous aneurysm); or it may at length end in gangrene of the part.

As a rule, the simpler methods of treatment succeed; a bandage is often enough, if the part is kept at rest; or, if this does not answer, Reid's method, digital compression, or flexion may be tried. If these fail and the aneurysm is superficial, the old operation may be resorted to without hesitation, as the walls of the vessel are healthy; but if it is deeply seated proximal ligature (the Hunterian method) should have the preference.

Rupture or even leakage, unless of the most trivial description, leaves no alternative; then it is simply a question of a ruptured artery, and it must be treated as such.

## Special Aneurysms.

### *Aneurysms at the Root of the Neck.*

Many forms of aneurysm are met with at the root of the neck, and the differential diagnosis is often very difficult. Roughly, they are divided into three classes, although sharp distinctions are seldom possible, and the dilatation is rarely limited to one part.

1. Those confined within the thorax. These spring usually from the first part of the arch of the aorta, occasionally from the third. They may be sacculated; but very often, even when a sacculus is present, it is only secondary to a wider fusiform enlargement.

2. Those that pulsate in the episternal notch, or behind the sterno-clavicular articulation or the sterno-mastoid, so that part of the outline of the sac can be felt.

These include sacculated aneurysms of the transverse portion of the arch; those that spread from the aorta into the base of the innominate; and aneurysms of the innominate itself, involving more or less of the carotid or subclavian. Aneurysms springing from the left extremity of the arch, and spreading in the direction of the

left carotid or subclavian, occasionally present in this region, but only in their later stages.

3. Those that lie entirely out of the thorax, the finger being able to feel the under surface of the sac. These must be either carotid or subclavian; even the high innominate form (so called to distinguish it from that which spreads upward from the aorta) descends too far.

The diagnosis of these different conditions rests upon the position and extent of the tumor with regard to the surface of the body, the evidence of pressure upon structures near, and the alteration in the pulse-wave. Thorough examination must always be made of the heart, to ascertain whether there is any mitral or aortic regurgitation, and of the other arteries. Any surgical operation that is undertaken must be of the most serious description, and should never be attempted unless other conditions are favorable. Fusiform dilatation, aortic disease, atheroma in other vessels, hypertrophy or dilatation of any of the cavities of the heart to any serious extent, and renal disease, are practically final, so far as active treatment is concerned.

Even taking the small number of cases left, those in which there is merely a sacculated aneurysm springing from an otherwise healthy vessel, active surgical treatment cannot be recommended until rest, diet, and simpler methods have been thoroughly tried. How long they should be kept up before adopting further measures depends upon the amount of improvement in each individual case. A certain degree is almost invariable at first if a patient who has been engaged in hard manual labor is laid up in bed and kept on low diet; the heart beats less quickly and less forcibly; the tension in the aneurysm falls; the surrounding tissues empty it to a certain extent by their pressure; and the pulsation becomes less distinct. If this continues, nothing better can be wished for, and it may be hoped that the sac will gradually become solid. Too often, however, it is only temporary; all the symptoms return even after a patient trial for months, and without the patient undertaking any exertion. For such as these, if the other conditions already enumerated are favorable, it is sometimes possible to adopt a more active line with benefit; but the proportion they bear to the whole is exceedingly small.

1. Aneurysm of the first part of the arch. This lies for the most part to the right of the middle line, causing an area of dullness that corresponds chiefly to the second rib and the second interspace, although it may reach as high as the sterno-clavicular articulation. Protrusion of the chest-wall takes place comparatively early, and is soon followed by the formation of a distinct swelling which pulsates visibly and sensibly. Over this region the heart-sounds are heard with abnormal loudness, the second especially. The heart itself is often displaced outward. There may be evidence of pressure upon the right bronchus, air not entering freely into the lung, or upon the superior vena cava, causing congestion of both arms and both sides of the head. The pulses are equal, carotid as well as radial, but the pulse-wave is slightly lower and more sloping than natural, and the down-stroke prolonged and undulating.

If rest and diet fail and the other conditions are sufficiently favorable, the choice lies between galvanopuncture, acupuncture, the introduction of foreign substances, simultaneous distal ligature of the right carotid and subclavian, and ligature of the left carotid. Of these the first three have never strengthened the sac sufficiently to enable the patient to lead an active life again, even for a time, and the last of them is very likely to end in embolism. Perhaps galvanopuncture is the best, especially if the current is kept up for some hours and the needles are retained until the clot is firm; but it has not yet been proved that the coagulum is capable of resisting for any length of time the immense force that must fall upon it in the first part of the aorta. The last two have each succeeded once or twice, although it was not known at the time that the aneurysm was situated in the first part of the arch. Ligature of the left carotid perhaps affords the best hope; it is not so serious an operation as the other, and if the rest of the aorta is not dilated, and the heart

is not diseased, there is a possibility of its proving successful. The condition of the other carotid must, however, be carefully investigated first.

2. Aneurysms that pulsate in the episternal notch. This is the most difficult class of all; it does not follow by any means that a tumor originates upon the side upon which it projects.

(*a*) The area of dullness and the locality of the pulsation rarely reveal much. If there is a distinct band of resonance opposite the level of the second costal cartilage, it is probable that the first part of the arch is intact, but it is not common to find this even after the fullest inspiration. Also, if the pulsation is limited to the region of the right sterno-clavicular articulation, the aneurysm probably involves the innominate artery, but it does not show that the dilatation is limited to this, and it does not exclude those varieties of sacculated aneurysm which ascend from the arch in front of the other vessels and pulsate in exactly the same locality.

(*b*) Pressure signs are more useful. Veins are often obstructed, the superior cava when the first part of the arch is concerned, the right innominate if the aneurysm extends upward along the innominate artery, the right internal jugular if the first part of the subclavian is involved, and the left innominate when there is a pouch projecting upward from the transverse part of the arch, along the innominate or independently. This last condition, in which the tumor, pulsation, and accentuated second sound of the heart are most distinct upon the right side, and the congestion upon the left, is very suggestive.

Nerves do not suffer so often. The left recurrent laryngeal is first irritated and then compressed in aneurysms of the distal portion of the arch, causing a peculiar paroxysmal cough with a high, squeaky voice, and in the later stages aphonia. The right suffers in the same way when the first part of the subclavian or the innominate is dilated. In every case of suspected aneurysm the condition of the vocal cords as regards position and movement during phonation should be carefully examined.

The sympathetic is not affected unless the aneurysm assumes a particular direction or becomes very large. Vascular dilatation, increased sweating, and contraction of the pupil are the chief symptoms.

Compression of the trachea or of one of its divisions may occur in almost any of the forms; the tone of the voice is not affected; the breath-sounds are changed; there is a loud, harsh blowing, often audible on both sides, even when only one is involved; violent fits of spasmodic coughing, ending in the expectoration of thick, ropy mucus, are of common occurrence, and the expansion of the chest is often unequal.

In other cases the œsophagus, the lower cords of the brachial plexus on one side, the sternal end of the clavicle, or the sterno-clavicular articulation are affected as the growth increases in size, and give important indications as to the direction in which it is extending.

(*c*) The condition of the pulse affords even more valuable evidence than this although it must always be remembered that the right subclavian sometimes runs an abnormal course, and may be compressed by an aneurysm springing from some other vessel. It is not, however, the absence of pulsation, so much as the character, the peculiar, low, sloping, aneurysmal curve, that is important, and, to obtain satisfactory evidence of this, tracings must be taken from both radials and both carotids. If those obtained from the two sides are approximately equal, the aneurysm probably involves the first part of the arch, though it is by no means certainly limited to it; if the right are affected, but not the left, the arch itself must be nearly intact; if the left without the right, the innominate must be sound; and the same with regard to the radial and carotid on either side.

If rest and diet fail, distal ligature is the only active treatment advisable for any of these, although one case of innominate aneurysm is stated to have been cured by distal compression of the subclavian and carotid. Galvano-puncture or the introduction of foreign bodies does not offer the least prospect of success

Those cases, however, only are suitable for it in which the tumor is distinctly limited in size, and in which the presence of fusiform dilatation of the aorta, hypertrophy and dilatation of the left ventricle, etc., can be excluded. The choice lies between simultaneous ligature of the right carotid and subclavian and ligature of the left carotid. The former is to be preferred, if from the condition of the pulse and the right venous congestion the symptoms point definitely to the innominate; the latter probably under other conditions.

3. Aneurysms of the right side of the root of the neck, lying outside the thorax. These are either carotid or subclavian. The reason for classing them here is the extreme difficulty of distinguishing them from the high innominate form.

In aneurysm of the first part of the subclavian the swelling appears first behind the clavicle, pushing that bone forward and causing a rather elongated area of pulsation. Paroxysmal cough with alteration in the tone of the voice from pressure on the recurrent laryngeal, venous congestion and œdema of the side of the head and neck from compression of the internal jugular, and weakening of the radial pulse are the chief distinctive signs.

When the base of the right carotid is involved the shape and position of the tumor and the direction of the pulsation are different; there is no pressure upon any nerve or vein, no dullness in the first intercostal space, and nothing in connection with the trachea, œsophagus, or recurrent laryngeal, until the tumor reaches a considerable size. On the other hand, the facial and temporal pulses are distinctly different from those on the opposite side.

If these two sets of symptoms occur together, even if they are only slightly marked, it means that the distal end of the innominate is involved; that practically it is a case of innominate aneurysm (the high form in distinction from the low one, which spreads upward from the aorta), and, as already described, that it can only be treated by rest and diet, or by simultaneous double distal ligature.

### Aneurysms of the Carotid.

The point of bifurcation is the most common situation, but almost any part, except that which lies inside the thorax on the left side, may be involved. The internal carotid is seldom affected, although a few cases are on record, and most of those in connection with the external are traumatic, and extend along its branches. It is peculiar that aneurysms of the common trunk are nearly as frequent among women as among men.

Two varieties are distinguished, the high and the low; the latter is almost, if not quite, confined to the right side.

**Symptoms.**—In addition to the ordinary signs, the presence of a circumscribed fluid tumor with characteristic pulsation and bruit, there are others caused by pressure upon neighboring organs and by interference with the cerebral circulation. Among the former may be classed dyspnœa, spasmodic coughing, and hoarseness from pressure upon the trachea, larynx, or recurrent laryngeal, dysphagia from the sac projecting into the pharynx or œsophagus (this is more common when the internal is affected), contraction of the pupil and other symptoms from paralysis of the sympathetic, and neuralgia from pressure upon the cervical nerves. The latter are due either to loss of arterial tension in the vessels of the brain, in the same way as in the facial and temporal branches of the external carotid, or to obstruction to the flow in the internal jugular. Giddiness, syncope, noises in the ears, dimness of vision, headache, and violent throbbing are not unfrequently present, and in addition there is always the risk of embolism, with paralysis of smaller or larger centres, from some fragment of clot being detached.

The diagnosis in many cases is exceedingly easy; in a few, however, it is a matter of the greatest difficulty. Aneurysmal dilatation is not at all uncommon at the bifurcation and at the origin of the right common trunk, and if noticed for the first time, or if it accidentally becomes more prominent from wast-

ing of the tissues around, it may cause considerable uneasiness. Probably the cases in which carotid aneurysms are recorded as having lasted unchanged for years were really examples rather of fusiform expansion than anything else. At the root of the neck, even if the diagnosis of aneurysm is certain, it may be impossible to prove that the carotid only is involved; aneurysms of the subclavian, the innominate, and even of the arch of the aorta, may simulate it perfectly, so far as position is concerned. Glandular enlargements are usually lobulated and multiple, and the only difficulty occurs when the artery runs through the centre of a mass of them. A few cases of cysts lying on the artery are on record, but the character of the pulsation is different, and although fluctuation is distinct the contents cannot be emptied out of the sac by pressure. Vascular growths of the thyroid, which occasionally pulsate, move up and down with deglutition, and can be traced into connection with the isthmus. Abscesses and pulsating malignant growths rarely give rise to trouble; the shape of the swelling, the relation it bears to the vessel, the absence of expansile pulsation, and the effects of distal and proximal compression are sufficiently distinctive. When the aneurysm is situated on the internal carotid, pressing against the tonsil and causing it to project into the pharynx, it may be mistaken for an abscess.

Spontaneous cure is very rare. Some cases remain quiet for a long time without enlarging, but the general tendency is for the tumor to increase until it ruptures into the pharynx, trachea, or externally. Suppuration may occur round it, especially after ligature, and embolism of the cerebral arteries, leading to hemiplegia, has happened in several cases—once, at least, while the tumor was being examined.

The only treatment possible is compression or ligature, proximal or distal.

The common carotid may be compressed with the fingers against the transverse process of the sixth cervical vertebra, or above this by grasping the artery behind the sterno-mastoid, between the finger and thumb, the patient's head being bent over to the affected side so as to relax the muscle. Instrumental compression is rarely successful. In any case, even when the greatest care is used, it is almost impossible to stop the flow of blood for more than two minutes, and often not that long at first, vertigo, faintness, and a sense of sickness coming on almost at once. Whether this is due to the interruption of the circulation or in part at least to the irritation of the vagus and sympathetic is uncertain. It is more important that after a number of sittings a certain degree of tolerance is established.

If this fails proximal ligature must be tried if there is room, distal if there is not. Neither is very successful, and it has been proposed, especially in traumatic cases (which, however, are too rare to enter into the question), to resort to the old operation. There is some reason, however, to believe that recent results are a good deal better. Suppuration of the sac, and hemiplegia and convulsions from cerebral anæmia, are not unusual consequences. Occasionally pulmonary congestion and hypostatic pneumonia occur, possibly from interference with the blood-supply of the base of the brain, but more probably from injury sustained by the vagus or the cardiac branches of the sympathetic.

Aneurysm of the external carotid presents no special features. The artery itself should always be secured in preference to the common trunk, if it can possibly be managed, as this avoids one of the most common causes of death. Sometimes it is necessary to tie one or more of the branches as well, owing to the special freedom of the collateral circulation.

Aneurysm of the extra-cranial portion of the internal carotid can only be treated by pressure or proximal ligature.

Aneurysmal varix occasionally occurs in the neck, as a result of stabs and other wounds, involving an artery and a vein. It is most frequent in connection with the common or internal carotid and the internal jugular; but it has been known to form between the common carotid and the subclavian vein, just where they cross. The immediate effect of such an injury is an enormous extravasation of blood; if this does not prove fatal, or end in suppuration, the orifices in the

vessels lying opposite each other may unite and prevent further loss. The symptoms are those already described, violent pulsation in the veins with dilatation and hypertrophy, palpitation arising from the unequal pressure in the auricle and the unusual character of the blood, and headache, giddiness, noise in the ears, etc., from interference with the cerebral circulation. In most cases there is a distinct thrill along the course of the vein; and a whizzing or purring noise can nearly always be heard, more or less, over the whole of that side of the head. Not unfrequently it is very distressing to the patient, even preventing sleep. Treatment should be palliative only.

### Orbital Aneurysm.

Orbital aneurysm is a clinical term used to describe certain pulsating tumors of the orbit, attended with exophthalmos, without implying the invariable presence of any single pathological lesion.

In those past middle life it may originate spontaneously or after some slight exertion, or at any age from such accidents as fracture of the base of the anterior fossa of the skull, gunshot injuries, or penetrating wounds of the orbit. Usually the symptoms appear within the first few months, often within a few days. At first there is merely a loud buzzing or roaring sound audible to the patient, then the conjunctiva becomes congested and perhaps chemosis follows. After a while the eyeball projects and begins to pulsate, the ocular muscles lose their power, the pupil becomes fixed, the hollow under the orbital arch is filled up, and a soft, pulsating mass makes its appearance at one angle of the orbit, usually the upper and inner. The veins of the eyelids, the bridge of the nose, and the forehead soon become distended and tortuous; a distinct thrill and a loud, rasping bruit are perceptible over the swelling; a large pad of infiltrated mucuous membrane protrudes between the lids; the pulsation of the eyeball becomes more and more distinct, and in many cases the transparency of the media is destroyed.

Before this occurs it may be noted with the ophthalmoscope that the disc is unduly prominent and the retinal veins enlarged. Small hemorrhages, too, may be present. Finally the opposite eye and orbit may become affected in the same way, and in extreme cases the dilatation of the veins may extend over a great part of the face.

The noises in the head and the bruit cease as soon as pressure is applied to the carotid on the corresponding side; if it is kept up the globe recedes and the pulsation diminishes or stops altogether.

It has been clearly demonstrated by Rivington that the pathological lesion underlying this condition is probably always a communication between the internal carotid artery and the cavernous sinus, sometimes caused by injury, sometimes due to the rupture of an aneurysm or the giving way of the floor of an atheromatous ulcer. The immediate effect is the rush of arterial blood, under high pressure, into the ophthalmic vein, causing at first merely pain and a peculiar buzzing noise audible to the patient; but later, as the vein becomes enlarged and distended, and as with its increasing size the pressure in its interior becomes greater and greater, giving rise to the exophthalmos and the signs of aneurysmal varix extending on to the face. The communication between the two cavernous sinuses explains the fact that one eye may become affected after the other.

Aneurysm of the ophthalmic artery may cause exophthalmos, but cannot produce a pulsating tumor at the angle of the orbit or the distention and thrill in the veins. The venous sinuses of the cranium not unfrequently become thrombosed, but do not of themselves lead to the development of pulsating tumors, although they may cause some degree of proptosis with passive congestion of the eyeball, dilated pupil, restricted movements, and diminished vision. Aneurysms of the internal carotid (unruptured) may project into the cavernous sinus without giving rise to the essential symptoms of this disorder. The rare examples of erectile and cavernous tumors met with in the orbit might produce something of the same

character, but without pulsation or bruit. Cirsoid aneurysms undoubtedly could, but it has never yet been found in this locality, and Rivington suggests that in many cases, in other parts of the body, especially where it has followed injury, it is really a form of aneurysmal varix itself rather than true cirsoid aneurysm.

The greatest difficulty occurs with pulsating sarcomata growing from the back of the orbit. For a time at least they may cause symptoms of an almost identical character, but the bruit is usually absent, and when it is present is of a very different description; and extension of the growth always takes place very rapidly.

**Treatment.**—The only treatment at all satisfactory in its results is compression or ligature of the common carotid. The former has seldom been tried, owing to the difficulty of maintaining it for more than a minute or two; but probably it deserves more attention than it has received. The latter has been very successful both in the traumatic and, though to a less extent, in the spontaneous variety. In one or two instances both vessels have been tied, though not at the same time, owing to persistence or recurrence of the symptoms. This may have been caused by the clot being washed away before organization had rendered it sufficiently firm, or by unusual freedom of communication between the two cavernous sinuses, or by the blood having found its way into the orbit through other veins as well as the ophthalmic. Vision is lost in a large number of cases, chiefly from ulceration of the cornea and collapse of the eyeball. This may sometimes be checked by early operation, certainly it is favored by delay; but it is impossible to predict what will result in any given case, as the ligature of the vessel itself under these circumstances may so interfere with the circulation through the eye as to impair the transparency of the media.

### Aneurysms of the Subclavian.

These, like aneurysms of the carotid and innominate, may be divided into two classes: those which are limited to the third part of the artery, that which descends beneath the clavicle, terminating at the lower border of the first rib; and those which implicate the first part, whether they are limited to this or extend over the rest as well. Like aneurysms elsewhere (with the exception of the carotid), they are much more common in men than in women, and, for the most part, occur upon the right side.

Subclavian aneurysms rarely attain large size before rupture takes place. They usually form an elongated swelling behind and above the clavicle, with all the characteristic signs of aneurysm, pulsation, bruit, etc. The pressure symptoms vary according to the locality; when the inner part is concerned, the recurrent laryngeal nerve and the internal jugular vein are compressed; when the outer, the subclavian vein, the external jugular, and some of the cords of the brachial plexus. In general, the prominence is chiefly upward, but occasionally the sac enlarges in the direction of the pleura, and it may become adherent to it; and sometimes the phrenic nerve, the trachea, and the œsophagus are compressed.

Enlarged glands may, as in the case of the carotid, surround the vessel and lead to a certain amount of difficulty in diagnosis; and chronic abscess may occur in connection with them or with other structures, and produce at first sight a closely similar appearance; but the effect of compression upon the artery or upon the sac is conclusive. The difficulty of determining how far inward the dilatation extends is often very great, especially on the right side; but, as a rule, the comparison of the pulse in the branches of the carotid on the two sides is enough to determine whether the innominate is involved or not.

Spontaneous cure is said to have occurred in a few cases from embolism. As a rule, the sac enlarges very slowly for a time, and then suddenly gives way, causing an immense extravasation, which may prove fatal from pressure, or may burst into the pleura, the trachea, or externally.

The treatment of subclavian aneurysm is most unsatisfactory. Proximal ligature, unless the aneurysm is really axillary rather than subclavian, is practically

hopeless. Ligature of the innominate or of the first part of the subclavian on the right side has proved almost invariably fatal from secondary hemorrhage; while on the left side ligature of the corresponding trunk is out of the question. Proximal compression is equally impossible, except in the case of some rare anatomical abnormality.

Distal ligature has not proved any better, probably owing to the very large collateral branches coming off from the sac itself or its immediate vicinity. Amputation at the shoulder joint has been performed on one or two occasions with the view of meeting this, but without sufficient success to justify repetition.

Rest and diet should be thoroughly tried in every case first. If they do not succeed, and the sac contains sufficient fibrin, direct pressure with manipulation affords the best hope, always provided the carotid is not involved. Under other circumstances, prolonged galvano-puncture would probably answer better; or an attempt might be made to procure solidification by the introduction of a short length of iron wire; but the prognosis in all such cases is very grave, and the risk of suppuration setting in very great.

### Axillary Aneurysm.

This is chiefly remarkable for the rapidity of its development and the frequency with which it can be traced to a definite injury. As might be expected, it is much more common among men than women, and nearly always occurs upon the right side. Any part of the artery may be involved, and it may project downward into the axilla, inward toward the thorax, so that the ribs become absorbed; or upward under the clavicle, raising the shoulder. The movements of the arm are naturally restricted, the head is inclined to that side, the elbow is abducted, and not unfrequently there is great pain running down the arm from pressure upon the brachial plexus, or œdema from occlusion of the axillary vein.

Spontaneous cure is very rare, if it ever happens. If left to itself the sac rapidly enlarges and either becomes inflamed and suppurates (to which it is especially prone) or ruptures into the loose cellular tissue of the axilla, the shoulder joint, or the thorax.

The treatment, if the aneurysm is limited to the axilla, is comparatively simple. Compression of the third part of the subclavian should be tried first; but after a short time it usually becomes exceedingly painful, and if it is kept up is not without danger to the brachial plexus. If it cannot be borne, Esmarch's bandage may be used under an anæsthetic, the circulation above being controlled with a rubber cord arranged round the axilla in a figure-of-eight, as high as possible; or a ligature may be placed round the third part of the subclavian. When, however, the clavicle is pushed up by an immense tumor, and it is doubtful how far the aneurysm is subclavian and how far it is axillary, the question becomes much more difficult. Rest and diet may succeed, but usually the tumor continues to increase unchecked. Direct pressure and manipulation are not suitable, owing to the thinness of the sac and the rapidity of its growth, while galvano-puncture and the introduction of foreign substances are almost sure to excite inflammation and very possibly suppuration. The best chance lies in ligature of the subclavian as far away as possible, dividing the scalenus anticus, and drawing the phrenic nerve inward out of the way, if it appears necessary. Any branch that comes off from the main trunk near the seat of ligature should be tied too, to diminish as much as possible the risk of secondary hemorrhage; but the operation is one of extreme difficulty, and, owing to the manipulation necessary, is very likely to be followed by inflammation either of the sac or of the pleura and its contents.

Aneurysms of arteries below the axillary are rare except as a result of embolism or injury. There is nothing special either in their symptoms or their

If everything is favorable, the choice lies between proximal or distal pressure opening the abdomen and introducing foreign substances into the sac, as in 's case already mentioned. Proximal pressure is undoubtedly the best of ; but, without opening the abdomen, it cannot be effected above the renal ries; the aorta lies too deeply and is covered with structures, especially the creas, which may not be bruised. If the abdomen is opened, as has recently done by Keetley, pressure can be applied almost directly to the vessel, but of e in such a case this itself is a serious matter. The bowels must be thoroughly ed out with aperients and enemata, the bladder emptied, and care taken that stomach contains no solid food. Then the patient must be placed under an sthetic, and Lister's or Carte's tourniquet carefully adjusted above the swelling, slowly screwed down until the pulsation of the aneurysm is checked. It need be said that this is only possible in a very limited number of cases. Once ed, no current should be allowed to flow through until it is determined to bring procedure to an end; any rush of blood, such as would ensue from relaxing pressure too soon, would at once sweep the coagulum away. How long compression can be maintained depends upon the condition of the patient. If there is sign of shock, it may be kept up for three or perhaps four hours; and possibly at end of that time pulsation may be so much diminished that consolidation will low of itself. In several cases, however, peritonitis has occurred, and proved tal from the amount of bruising. Afterward, and for some time, the patient st be kept as quiet as possible in the hope that the coagulum will remain firm.

Where this cannot be carried out, distal compression may be tried. In a few instances the two have been used together so as to ensure complete cessation of the circulation through the sac. By itself it is certainly not so effectual.

Cessation of pulsation is attended by great loss of power with coldness and deficient sensibility in the parts below. After a time, if they are kept warm and protected from injury, this passes off and pulsation can be detected in the larger trunks again; but naturally the collateral circulation, in man at least, can scarcely become sufficiently developed to replace the aorta.

### Iliac Aneurysm.

Aneurysm of the common, external, or internal iliac artery forms a soft, circumscribed swelling in the line of the vessel, with characteristic expansive pulsation and bruit continued along its course. The pain is rarely severe unless the obturator or genito-crural nerve is involved; and owing to the space around, other signs are often wanting until the tumor has reached a large size. If left it usually ends in rupture; but in one or two instances œdema and gangrene have occured from venous obstruction.

**Diagnosis.**—Aortic aneurysm, springing from just above the bifurcation, has been known to spread down as low as Poupart's ligament. Enlarged glands round the artery may cause a momentary doubt. Tumors growing from the bones, especially pulsating sarcomata, are much more difficult; but in most cases they may be distinguished by their extent, position, attachment to the bone, feeble, ill-defined bruit, and different pulsation. Moreover, they cannot be emptied by pressure; they do not alter the pulse-tracing in the same way; and the bruit (when there is one) is not carried along the artery. Abscesses in the same region require careful examination, as aneurysms not unfrequently send outlying pouches, which scarcely pulsate, under Poupart's ligament. In every case the rectum should be thoroughly explored.

**Treatment.**—This depends upon the position, whether the common trunk is affected, or merely that part of the external branch which lies near Poupart's ligament. In the former case, if rest and diet do not soon effect a decided improvement, the same treatment must be adopted as for aneurysm at the bifurcation, proximal pressure with or without distal. If low down, either the same plan may be tried, or the common or external iliac may be ligatured according to the height

to which the sac ascends. Where neither of these methods is practicable, galvano-puncture affords the best hope; distal ligature has never proved successful, and the injection of coagulants (although perchloride of iron once very nearly succeeded) is almost certain to give rise either to gangrene of the limb or suppuration of the sac.

### Aneurysm of the Branches of the Internal Iliac.

The gluteal, and less frequently the sciatic and pudic arteries, are occasionally the seat of aneurysms, the majority being traumatic in origin. In some cases, especially when the sciatic is concerned, the sac lies partly inside the pelvis, partly outside; in most it is altogether extra-pelvic. The mode of origin gives no clue to this, as either of the arteries may be wounded in the sacro-sciatic foramen and then retract; the only way in which it can be ascertained is by rectal or, in the female, vaginal examination.

**Symptoms.**—When the aneurysm is small, these are very vague, owing to the depth at which it is situated. There is pain along the course of the sciatic nerve; the movements of the hip are limited, especially in the direction of flexion; and usually there is a hard, deep, ill-defined swelling. Pulsation and a bruit are rarely absent when it has reached any size, but so long as the sac is small it is very difficult to make certain. If left, spontaneous cure is possible, but very rare; much more often the sac continues to enlarge; the muscle and the tissues over it waste; and at length rupture takes place. There is no means of telling sciatic from gluteal aneurysm, although the former is more probable if the sac can be felt inside the pelvis.

**Diagnosis.**—*Pulsating Sarcoma.*—In its early stages this is very difficult; later, rectal examination or puncture with a fine trocar and cannula will give sufficient evidence. A bruit is greatly in favor of the tumor being aneurysmal, as it is rarely present in a sarcoma until this has attained a considerable size, and even then it is much softer in tone.

*Abscess.*—The absence of pulsation and bruit is usually sufficient in chronic abscesses, the signs of suppuration in acute ones, but it must be remembered that gluteal aneurysms not unfrequently suppurate.

*Enlarged Bursa.*—The subgluteal bursa may become distended with blood or serous fluid, but there is no bruit or pulsation, in spite of the thinness of the walls, and there is no tension upon the contents.

### Femoral Aneurysm.

Aneurysm may occur in the course of the common, the superficial, or the deep femoral artery. Usually it is sacculated, but occasionally fusiform; sometimes in Hunter's canal it is rather flattened.

As a rule there is no difficulty in the diagnosis, all the characteristic signs being present, but not unfrequently it is almost impossible to distinguish whether the dilatation is on the superficial or the deep branch; the former of the two is much the more common, and affects the pulse below to a greater extent, but this cannot always be relied upon. Of course if the pulsation of the superficial trunk can be distinctly made out overlying the deep one, there is no difficulty.

The treatment consists in proximal pressure, instrumental or preferably digital, and if this fails, ligature. If the aneurysm is in Hunter's canal, the same artery may be tied higher up; if in Scarpa's triangle, or if the profunda is involved, the choice lies between ligation of the external iliac or of the common femoral. The former is usually preferred, owing to its freedom from branches at the seat of ligature, the better development of the collateral circulation, and the fact that it is less frequently atheromatous; but the latter has been shown to be very successful in actual practice.

### Popliteal Aneurysm.

The popliteal artery is the most common seat of aneurysm, except the aorta itself. It is peculiarly liable to atheroma; it is not supported by the structures around; it is compressed more or less in flexion of the knee, stretched out in over-extension, sometimes even ruptured; and immediately below it breaks up into a number of branches, so that an embolus, if it comes down the vessel, is almost certain to lodge there. That constitutional causes are of very great importance is shown by the fact that it sometimes occurs on both sides, and that it may even develop upon the second while the patient is lying in bed being treated for the first.

Fusiform dilatation is occasionally met with, but sacculated aneurysm is much more common. In some cases it springs from the anterior surface of the artery and grows forward against the bone or the posterior ligament of the knee joint, and then it is usually slow in its course, rarely attaining a large size. In others it extends backward, and, meeting with little to oppose it, becomes immense, forming a thin-walled sac within comparatively a short space of time.

**Symptoms.**—Occasionally the onset is sudden, dating from some exertion; more frequently, the patient suffers from obscure rheumatic pain down the leg with stiffness of the joint and a sense of weakness, and then suddenly discovers, or has discovered for him, the presence of a pulsating swelling. Usually the expansive pulsation, the bruit conducted down the leg, and the way in which the sac empties upon compression and fills again on relaxation of the vessel are distinctive. Occasionally the tumor is harder and cannot be emptied, the pulsation is that of an artery only, and the bruit is indistinct and faint; and in some very rare instances there is no pulsation at all. Probably, in the former case, the sac is already partly filled with fibrin, and possibly in the latter it is completely solid; but as pulsation sometimes makes its appearance later, this explanation is hardly satisfactory.

If the sac grows forward, synovitis of the knee joint sets in, the pain is very severe, and movement greatly restricted. If it takes a direction backward, the popliteal vein may be compressed and congestion and œdema follow; or the internal popliteal nerve may be stretched so that there is severe neuralgia extending down the side of the limb into the sole of the foot. Sometimes a distinct difference can be made out in the two tibial pulses.

Left to itself it occasionally undergoes spontaneous cure. Much more frequently it grows larger and larger, leaks, and ruptures either into the knee joint, or more usually into the cellular tissue of the leg. In either case the patient is con-

scious of something having given way, and becomes sick and faint with the pain and loss of blood. If the rupture takes place through the posterior ligament the knee becomes immensely distended at once, but the bruit and pulsation do not altogether cease, and the pulse can still be felt, though feebly, in the posterior tibial. If it is into the cellular tissue, a tense swelling forms rapidly in the popliteal space, filling it completely and causing the most severe pain; the limb below becomes cold and livid, the tibials cannot be felt, and in a very short time gangrene sets in. Occasionally inflammation breaks out round the sac, the skin becomes red, œdematous, and exceedingly painful, and sometimes this is followed by suppuration.

The diagnosis must be made from sarcoma growing either from the bones, the posterior ligament of the knee joint, or the lymphatic glands; abscess; bursal cyst, or diverticulum from the knee joint; and solid tumors resting upon the artery. Arterial hæmatoma from perforation of the popliteal artery gives rise to the same symptoms as a leaking or a ruptured aneurysm, according to the size of the opening. In one case under my care there was a distinct bruit with faint pulsation along the course of the vessel.

**Treatment.**—Rest and diet are employed here only as adjuncts, but they should never be neglected, and unless the sac is enlarging rapidly, so that there is fear of rupture, it is always advisable to submit the patient to a few days' preparation before employing any active treatment.

If the aneurysm is of moderate size only, and there is no fear of immediate rupture, Reid's method with Esmarch's bandage, or digital compression, is the best, preference being given to the latter if there is much evidence of atheroma or of heart-disease; to the former if, other things being suitable, there are enlarged glands in the groin. Flexion succeeds well with those that are small or already partially solidified.

If these measures fail, or if the sac is enlarging rapidly and perhaps leaking, or if inflammation has set in, or if there is any œdema of the foot from pressure upon the popliteal vein, the artery should be tied at once at the apex of Scarpa's triangle, and the limb well wrapped in cotton-wool and raised.

Moist gangrene after ligature, rupture of the sac into the cellular tissue or into the knee joint, disease of the knee joint, caries of the lower end of the femur, and suppuration round the sac, require amputation. If dry gangrene occurs, the parts may be covered with some antiseptic powder, raised, and wrapped in cotton-wool, in the hope that a line of demarcation will form. Recurrent pulsation after ligature must be treated by compression, Esmarch's bandage, or flexion; if these fail and the patient is a young man with the rest of his arteries healthy, the external iliac may be tied; if old, it would probably be better to amputate at once. If secondary hemorrhage occurs from the seat of ligature, the wound must be opened and both ends tied; if this does not succeed, or the wound is in such a condition that success is improbable, amputation should be performed.

## SECTION IV.—OPERATIONS ON ARTERIES.

Arteries may require to be compressed so as to check the flow of blood for a time, or ligatured. In either case it is usual to select certain points, owing to their being more accessible, or further removed from important structures, or because of the condition of the collateral circulation. Wounds of arteries have been already dealt with.

### General Rules for Ligature.

The position of the patient must be such as to bring the artery as near the surface as possible, and at the same time make the various anatomical features of the limb stand out distinctly.

The exact course of the vessel must be made out by feeling for its pulsation where this is possible, and by making use of the ordinary anatomical guides. In many cases it is advisable to mark it out upon the skin with an aniline pencil. Careful examination must be made for any abnormality either of the trunk itself or of its branches.

Other things being equal, the spot selected should always be far away from any large branch. If this is impossible, or if when the artery is exposed it is found that one is near, it should be tied as well.

As a rule, the incision should be in the course of the vessel, over it (exceptions will be mentioned later on), the middle corresponding to the spot at which the artery is to be tied, and the length depending upon the amount of fat that is present and the depth of the vessel.

The first incision should divide the skin and the superficial fascia, taking care to avoid any large subcutaneous veins, such as the internal saphena or the external jugular.

The deep fascia should be divided on a director to the same extent, and this holds good for every other incision ; the bottom of the wound, that is to say, should be kept throughout in the same plane, not deeper in one part than in another.

Each anatomical structure should be recognized as it is exposed, the operator carefully making out the various landmarks in turn.

Muscles, when identified, should be drawn to one side, the fascia which binds them down being divided if necessary, and the position of the limb being changed if they are too tense.

The sheath of the vessel is recognized by its position, by the pulsation of the artery, and by the sensation the finger receives. When an artery is compressed it feels like a flattened band with thick and rounded edges, and it empties beyond the finger ; a vein can hardly be felt at all, while a nerve is round and solid.

The sheath is formed of dense fibrous tissue, and in the larger arteries is separated from the outer wall of the vessel by more or less of a space traversed by minute blood-vessels and delicate connective tissue. In many cases the vein is enclosed with it, in a separate compartment, and sometimes a nerve as well. The nutrition of the coats of the artery depends almost entirely upon the vessels it receives in this way, and consequently the opening must be as small as is conveniently possible, the sheath must be separated as little as can be, and care must be taken to open the right compartment. The loose areolar tissue that covers the sheath is lifted up with a pair of forceps at one spot, so as to form a small cone ; the side of this is cut with a scalpel held upon the flat, so that the edge does not at any time face the artery, and an opening made sufficiently wide to see the bluish-white external coat of the vessel beneath. One edge of this opening is held up

sterno-cleido mastoid], ending on the sternum, the other outward from
er end of this along the upper border of the clavicle ; the flap so formed is
d outward on its base.
e sternal head of the sterno-mastoid and the greater portion of the clavicular
divided upon a director, close to their origin, and reflected in the same
n as the skin. The anterior jugular vein is drawn on one side or tied, as
e requires. The sterno-hyoid and the sterno-thyroid muscles are divided
s they are exposed. The third layer of the cervical fascia is now laid bare.
sion is made in this over the common carotid ; the artery is followed down-
ith the finger until the origin of the subclavian can be felt and seen ; the
l jugular vein and the pneumogastric nerve are drawn to the other side, and
erior surface of the sheath cleared by gently separating the loose fat and the
ns thyroid and other veins lying in it. The pleura is pushed to the right,
ns to the left, the sheath opened in between, and the needle passed from right

very great deal depends upon the length of the vessel. If possible there
be at least half an inch between the bifurcation and the ligature, and, to
this, part of the sternum and clavicle may be cut away if necessary. If
s not so much the base of the carotid should be tied as well, but there is
sufficient of the subclavian. The operation has succeeded only once in
en times, secondary hemorrhage having nearly always occurred from the
end ; but possibly with more suitable animal ligatures of sufficient size and
th better results may be obtained. Several patients lived for long periods,
y Thomson's, of Dublin.
édillot recommends a single longitudinal incision between the two heads of
rno-mastoid, as enabling a better examination to be made of the bifurcation
e branches.

### Ligature of the Common Carotid.

he line of the artery, whatever the position of the head, runs from the sterno-
lar articulation to the lobule of the ear. It extends from the joint as high
pper border of the thyroid cartilage, and is crossed opposite the cricoid
ge by the omo-hyoid. It may be tied at the root of the neck, below the
yoid or above it. If a choice is allowed the point selected is at the upper
of the muscle.
- *At the Root of the Neck.*—The position of the patient at first is the same
ligature of the innominate. Afterward the head is slightly raised and
l to relax the sterno-mastoid muscle.
ither the angular incision may be used or Sédillot's longitudinal one between
o heads of the muscle. The preliminary steps are the same as those
ed already, the sternal head of the sterno-mastoid being divided on a direc-
ufficient room cannot be obtained without. The sterno-hyoid and sterno-
muscles are drawn inward with a retractor or notched, the cervical fascia
great care being taken not to wound the numerous thyroid and other
hat lie beneath, and the sheath of the vessel exposed. This must be
well to the inner side and the needle passed from without inward. On
at side the pneumogastric and the jugular recede somewhat from the artery,
y may be drawn still further away by applying a retractor to the clavicular
the sterno-mastoid ; on the left the vein may overlap it, and the thoracic
ies immediately behind. The ligature should always be placed on the
as far as possible from its origin, and this operation should not be selected
from the presence of aneurysm or from other cause, no choice is left.
attempted the artery will be found to lie much deeper than is generally
ed.
and 3. *Ligature Immediately Above or Below the Omo-hyoid Muscle.*—The
n of the patient is the same, the head being turned to the opposite side.
cision two inches and a half in length is made along the inner border of the

with a pair of fine forceps, to make it tense, and the vessel
its sheath with an aneurysm-needle or a director. The oth
hold of and the prc
side, until the wh
detached for a very
aneurysm-needle is
(unthreaded), keep
wall of the vessel a
ning on the side
important structure
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opposite edge of
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drawn outward in o
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tissue covering the
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sible (Fig. 55).

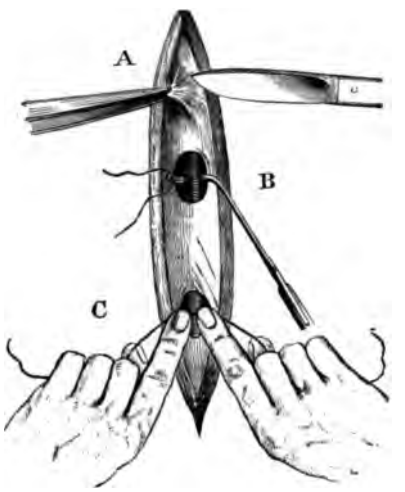


FIG. 55.—This diagram represents three distinct operations. A. Opening the Sheath. B. Drawing Ligature round the Artery. C. Tying Artery.

When the ne
the vessel is compr
the finger, to mak
artery (pulsation
that nothing else
Then the needle i
drawn.

FIG. 56.—Aneurysm-needle.

A reef-knot sh
A few attempts ha
stitute a loop or hi
jection, but the same reliance cannot be placed upon it. Th
should be sufficient to draw the inner coat well together. W
it in the middle depends upon the shape and material of
flat band (such as Barwell's ox aorta) it certainly will not;
very doubtful; with fine gut, kangaroo tendon, or silk, ther
any case, the greatest care should be taken, in tying the knot
unnecessarily from its bed; the fingers must be brought dow

When a double ligature is used and the artery divided i
separated from its sheath for some little distance; how far d
The object is to enable the two ends to retract thoroughly.
beyond the ligatures are practically cut off from the circula
as the end of an artery that is tied or twisted on the face o
either slough or become infiltrated with organizing lymph, acc
of the wound and the addition or not of suppuration. This p
in every case in which a sufficient length of artery can be e
fering with the part too much.

### LIGATURE OF THE INNOMINATE.

The line of the artery runs from the middle of the m
sterno-clavicular articulation; the point of bifurcation is
upper border of the joint.

The patient lies on his back with the shoulders slightly
turned toward the left. The operator stands upon the right

The incision is triangular; one side extends for three i
border of the right sterno-mastoid [in Smyth's case the inc

the *left* sterno-cleido mastoid], ending on the sternum, the other outward from the lower end of this along the upper border of the clavicle; the flap so formed is reflected outward on its base.

The sternal head of the sterno-mastoid and the greater portion of the clavicular one are divided upon a director, close to their origin, and reflected in the same direction as the skin. The anterior jugular vein is drawn on one side or tied, as the case requires. The sterno-hyoid and the sterno-thyroid muscles are divided as far as they are exposed. The third layer of the cervical fascia is now laid bare. An incision is made in this over the common carotid; the artery is followed downward with the finger until the origin of the subclavian can be felt and seen; the internal jugular vein and the pneumogastric nerve are drawn to the other side, and the anterior surface of the sheath cleared by gently separating the loose fat and the numerous thyroid and other veins lying in it. The pleura is pushed to the right, the veins to the left, the sheath opened in between, and the needle passed from right to left.

A very great deal depends upon the length of the vessel. If possible there should be at least half an inch between the bifurcation and the ligature, and, to obtain this, part of the sternum and clavicle may be cut away if necessary. If there is not so much the base of the carotid should be tied as well, but there is never sufficient of the subclavian. The operation has succeeded only once in eighteen times, secondary hemorrhage having nearly always occurred from the distal end; but possibly with more suitable animal ligatures of sufficient size and strength better results may be obtained. Several patients lived for long periods, notably Thomson's, of Dublin.

Sédillot recommends a single longitudinal incision between the two heads of the sterno-mastoid, as enabling a better examination to be made of the bifurcation and the branches.

### Ligature of the Common Carotid.

The line of the artery, whatever the position of the head, runs from the sterno-clavicular articulation to the lobule of the ear. It extends from the joint as high as the upper border of the thyroid cartilage, and is crossed opposite the cricoid cartilage by the omo-hyoid. It may be tied at the root of the neck, below the omo-hyoid or above it. If a choice is allowed the point selected is at the upper border of the muscle.

1. *At the Root of the Neck.*—The position of the patient at first is the same as for ligature of the innominate. Afterward the head is slightly raised and rotated to relax the sterno-mastoid muscle.

Either the angular incision may be used or Sédillot's longitudinal one between the two heads of the muscle. The preliminary steps are the same as those described already, the sternal head of the sterno-mastoid being divided on a director if sufficient room cannot be obtained without. The sterno-hyoid and sterno-thyroid muscles are drawn inward with a retractor or notched, the cervical fascia divided, great care being taken not to wound the numerous thyroid and other veins that lie beneath, and the sheath of the vessel exposed. This must be opened well to the inner side and the needle passed from without inward. On the right side the pneumogastric and the jugular recede somewhat from the artery, and they may be drawn still further away by applying a retractor to the clavicular part of the sterno-mastoid; on the left the vein may overlap it, and the thoracic duct lies immediately behind. The ligature should always be placed on the artery as far as possible from its origin, and this operation should not be selected unless, from the presence of aneurysm or from other cause, no choice is left. If it is attempted the artery will be found to lie much deeper than is generally expected.

2 and 3. *Ligature Immediately Above or Below the Omo-hyoid Muscle.*—The position of the patient is the same, the head being turned to the opposite side. An incision two inches and a half in length is made along the inner border of the

sterno-mastoid; usually its centre lies opposite the cricoid cartilage, but it may be higher or lower as the case requires. The skin, superficial fascia, and platysma are divided first; the deep fascia is slit up on a director, exposing the inner border of the sterno-mastoid, and avoiding, if possible, the sterno-mastoid artery, thyroid veins, and a communicating vein that often runs down along the inner border of the muscle from the facial to the anterior jugular. If this cannot be done the vessels must be tied. The head is now slightly raised, the sterno-mastoid drawn outward, the sterno-hyoid and sterno-thyroid inward, the deep fascia divided, and the omo-hyoid exposed lying upon the sheath, with usually some filaments of the descendens noni nerve. The sheath is opened on the inner side, avoiding the veins which often cross the upper part, and the needle introduced from without inward.

This operation may be required for wound of the artery, for hemorrhage from

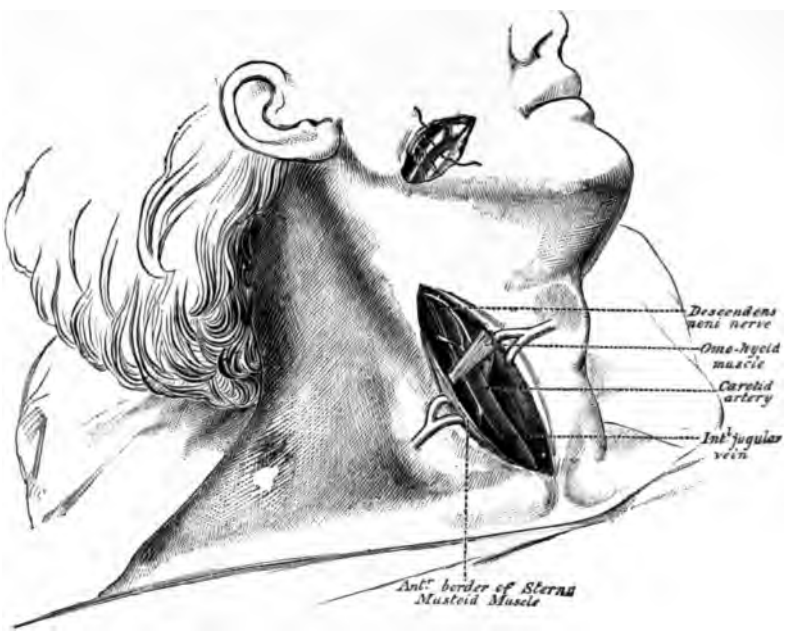


FIG. 57.—Ligature of the Common Carotid and Facial Arteries.

or aneurysm of either the trunk or any of the branches of the internal or external carotid, or as part of the distal operation for aneurysm of the innominate of the aorta. Owing to the effect upon the circulation through the brain the two carotids should never be tied simultaneously, and if one is blocked the effect of temporary pressure should be tried upon the other before a permanent ligature is applied. Life has been maintained after both carotids and one vertebral have been obstructed; but, on the other hand, symptoms of cerebral anæmia have occasionally followed ligature of one, and not unfrequently that of both, even when the operations were performed with a considerable interval.

The common carotid can be compressed against the tubercle on the transverse process of the sixth cervical vertebra (the cricoid is opposite the fifth) by pressure backward, or a little above this by grasping the artery between the finger and thumb, behind the sterno-mastoid when it is relaxed. Both are very painful and liable to cause syncope if kept up for more than a minute or two.

### Ligature of the External Carotid.

The line of the artery runs from the back of the thyroid cartilage almost directly upward to the posterior part of the condyle of the lower jaw. The position of the patient is the same, with the face turned rather more to the opposite side.

An incision is made from behind the angle of the lower jaw to a short distance below the upper border of the thyroid cartilage, dividing the skin, superficial fascia and platysma, and watching carefully for the anterior division of the temporo-maxillary vein. This emerges from the lower border of the parotid and runs to join the facial, piercing the fascia either just below the gland or some little distance down. The anterior margin of the sterno-mastoid is then defined, its sheath laid open, and the deep fascia beneath carefully divided upon a director. The artery is usually tied opposite the cornu of the hyoid bone, the sheath being opened a little below and the needle passed from without inward. Any veins that come in the way—thyroid, lingual, or facial—are either pulled on one side or tied with a double ligature and divided. If the temporal pulse is watched there is no fear of mistaking the trunk of the internal for that of the external, although it often lies more superficially at its origin.

The usual seat of ligature, at the level of the cornu of the hyoid bone, lies between the superior thyroid and lingual arteries. When, however, the object is to cut off the blood-supply from the middle meningeal or some other branch of the internal maxillary, the vessel may be secured immediately under the margin of the parotid.

Ligature of the external carotid is a very much more favorable operation than that of the common, partly because it avoids one of the great sources of collateral circulation and secondary hemorrhage, partly because it does not interfere with the blood-supply of the brain. It should always be adopted in preference where it can be shown that one of its branches—the middle meningeal, for example—has been injured, or where this is exceedingly probable, as in stabs and other injuries in the region of the parotid. On the other hand, in punctured wounds of the tonsil, in cases of sloughing diphtheritic and scarlatinal ulcers, and when the seat of the injury is in the region of the greater cornu of the hyoid bone, where the internal carotid is more superficial than the external, ligature of the common trunk affords the better prospect, always provided that the bleeding point cannot be secured *in situ*. It must be remembered, with regard to injuries of the tonsil, that wounds of the ascending pharyngeal are no less fatal than those of the carotid: when a small branch arises from a main trunk the pressure in it near its point of origin is scarcely less than that in the trunk itself.

### Ligature of the Internal Carotid.

This can be done through the same incision, the external carotid being drawn forward and the internal jugular vein backward. The needle is passed from without inward. The operation has been performed in a fair number of cases with success.

### Ligature of the Lingual Artery.

The chief landmark is the greater cornu of the hyoid bone. The artery arises from the external carotid opposite this (when the body is in the position for ligature), and runs some little distance along its upper border. It may be tied either before or after it passes beneath the posterior belly of the digastric.

[It should be remembered that occasionally this artery is given off from the superior thyroid instead of the external carotid.]

The head of the patient is thrown well back and turned toward the opposite side.

1. ***Behind the Digastric.***—The incision, two inches in length, starts from the

margin of the sterno-mastoid, and runs slightly curving upward immediately above the greater cornu. The skin, superficial fascia, and platysma are divided, watch being kept for the facial vein toward the posterior angle of the wound. If it is seen it must be pulled on one side. The projection of the submaxillary gland fills the upper portion of the incision and overlaps the other structures; the deep fascia is divided on a director along its lower border, the gland pushed up, out of the way, the tip of the greater cornu drawn down with a hook, and the posterior margin of the digastric defined. The angle between this and the upper margin of the hyoid is then carefully cleaned, the hypoglossal nerve pushed upward, the ranine vein avoided, and the posterior fibres of the hyoglossus exposed. These are either divided on a director, pushing it between them and the middle constrictor; or by picking them up with a pair of forceps and cutting through them layer by layer. The artery lies with one, and sometimes two veins, close above the bone.

2. *After it has Passed the Digastric.*—The position is the same, but the incision starts half an inch below and external to the symphysis, runs downward to the junction of the greater cornu and the body, and then turns upward to a little below the angle of the jaw. The structures are divided in the same way, the submaxillary gland pushed up, and a triangle exposed formed by the two bellies of the digastric and the hypoglossal nerve, dipping under the mylohyoid in front. The fat and loose cellular tissue which fill this space are removed, care being taken not to injure the ranine vein; the fibres of the hyoglossus, which form the floor, divided layer by layer; and the lingual artery, with its one or two veins, exposed, lying parallel to the upper border of the bone.

### Ligature of the Facial Artery.

This may be tied at the anterior border of the masseter, where it is only covered by skin, platysma, and fascia. A short transverse incision along the lower margin of the jaw is all that is required. The vein lies behind. It can easily be compressed in the same situation.

### Ligature of the Temporal Artery.

A short vertical incision immediately in front of the ear over the root of the zygoma is all that is required. The artery lies in some rather dense cellular tissue at this spot, with, as a rule, a single vein.

The occipital artery may require to be ligatured in the scalp, midway between the mastoid process and the external occipital protuberance; but in most cases, like the branches of the temporal, it can readily be controlled by pressure. In its deeper part, where it lies under the mastoid, it is almost inaccessible and is practically out of the reach of injury.

### Ligature of the Subclavian Artery.

The first part of the right subclavian has been tied fourteen times with a uniformly unsuccessful result, and, except in the case of some abnormality among its branches, it is difficult to see how it could be otherwise. The first part of the left is quite out of the question. On the other hand, ligature of the third part, on either side, is a very successful operation.

1. *Ligature of the First Part of the Right Subclavian.*—The artery extends forward, upward, and outward from the bifurcation of the innominate behind the sterno-clavicular articulation.

The position of the patient and the line of the incision are the same as for ligature of the innominate; the inner border of the clavicular origin of the sterno-mastoid is divided as far as required, and the outer of the sterno-hyoid and sterno-thyroid, exposing the anterior jugular vein and the deep layer of the cervical fascia. The

former is tied or pulled on one side, the latter divided very cautiously ; the internal jugular vein, with the vertebral, running down to join the innominate, drawn outward ; the innominate, if it rises too high, pressed downward, and the connective tissue gently separated until the bifurcation of the innominate artery is exposed on one side and the origin of the vertebral on the other. The vagus should be recognized and pressed inward toward the carotid, so as to avoid any injury to the recurrent laryngeal. If there is sufficient space between the origin of the vertebral and the point of bifurcation, the sheath is opened midway and the needle passed from below upward and inward, remembering that the artery rests upon the pleura behind as well as below ; if the length is too short, the vertebral should be tied as well.

2. *Ligature of the Third Part of the Subclavian.*—The patient lies on the back with the shoulders slightly raised, the head turned to the opposite side, and the arm drawn downward to depress the clavicle as much as possible. The height to

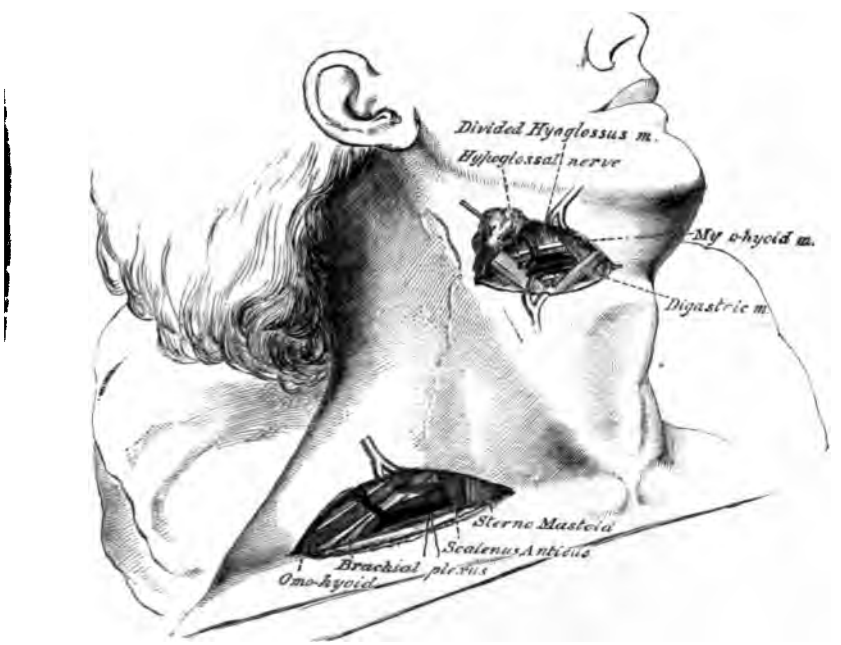


FIG. 58.—Ligature of Subclavian and Lingual Arteries.

which the artery ascends above the clavicle is very variable, particularly on the right side ; it may be almost concealed behind the bone, especially when the neck is short and the curves well marked ; or it may rise an inch and a half above it. The pulsation can always be felt upon the first rib between the trapezius and the sterno-mastoid.

The course of the external jugular vein should be ascertained first. Usually it pierces the deep fascia an inch above the clavicle, just posterior to the sterno-mastoid. The incision, two inches and a half or three inches in length, is parallel to the clavicle, immediately above it, with its centre corresponding to the interval between the sterno-mastoid and trapezius ; the skin, superficial fascia, platysma, and descending branches of the cervical plexus are divided ; there is no need to draw the skin down on to the bone. If the external jugular vein is exposed it should be drawn to one side. The deep fascia is cut through upon a director, and if the interval between the muscles is very small, the edge of one or other or both

may be notched. The space thus exposed is filled with loose cellular tissue containing a venous plexus formed by the terminations of the external jugular, supra-scapular, and transverse cervical veins, a branch from the cephalic, and sometimes the anterior jugular as well. To avoid wounding these, the tissues must be carefully separated with a director behind the margin of the sterno-mastoid, until the edge of the scalenus anticus is felt with the finger. If this is traced down to the tubercle on the rib, the artery is made out at once, unless there is the rare abnormality in which it follows the course of the vein. As a rule, the sensation of the flattened band with rounded edges is characteristic, even if the pulsation cannot be felt. The chief difficulty arises with the lowest cord of the brachial plexus, but if care is taken to include only that structure which lies next to the scalene tubercle, and to feel the radial pulse before the ligature is tightened, it is scarcely likely to be mistaken.

The artery in this situation is surrounded by a dense funnel-shaped sheath prolonged from the cervical fascia; this is opened by a small incision, and the needle passed from above, downward, behind the artery, so as to avoid taking the lowest cord of the plexus.

The posterior belly of the omo-hyoid, the subclavian vein, and the transverse cervical artery are rarely seen. The supra-scapular branch may be in the way, running parallel to the clavicle, but it can always be drawn on one side. The third part of the artery is just free from the pleura. In many cases the posterior scapular or some other large branch arises almost from the spot at which the artery is usually tied; if there is sufficient room the ligature is placed as far as possible on the distal side; if there is not, the branch is tied as well. In some few cases, chiefly where the operation is done for aneurysm of the axillary, extending upward under the clavicle, the outer margin of the scalenus anticus must be divided, and the second part ligatured. In doing this, care must be taken to avoid the pleura, which lies behind and below it; the transverse cervical and supra-scapular arteries, which not unfrequently cross it; and the phrenic nerve, which runs down upon the scalenus anticus, but usually leaves it just before it reaches the level of the artery. In any case it is advisable to keep the line of division low down, but the position of the subclavian vein must be recollected.

The third part of the subclavian artery is easily compressed against the first rib, unless the neck is exceedingly short and thick. The operator stands behind the patient's shoulder and uses the thumb of the same hand (right, that is to say, for the right subclavian) pressing downward, inward, and backward. If there is any difficulty, it is probably because the artery makes rather a higher curve than is expected. Sometimes a compressor is used, but the brachial plexus cannot then be so well avoided.

### Ligature of the Vertebral Artery.

This has been performed for secondary hemorrhage after ligature of some of the larger trunks, and for epilepsy. The operation, however, so far as this last-mentioned affection is concerned, has been practically abandoned, although some of the cases derived considerable temporary benefit.

The position is on the back, with the head slightly turned to the opposite side. There is no line for the artery; the guide to it is either the transverse process of the sixth cervical vertebra, or the interspace between the scalenus anticus and the longus colli.

The incision is three inches in length, down the posterior margin of the sterno-mastoid; the external jugular vein must be avoided and drawn inward with the muscle. The fascia beneath is carefully divided until the scalenus anticus, with the phrenic nerve and the transverse cervical artery, are recognized. Avoiding these, the inner border of the scalenus anticus is to be made out, and next to this, lying between it and the longus colli, is the artery. The transverse process of the sixth cervical is a further guide to the division if it is required. The vein lies almost

always in front of the artery. Alexander, who has had the chief experience in this operation, recommends that it should be drawn inward or outward, whichever is most convenient, with an aneurysm-needle. Another needle is then passed from without inward, behind the artery, threaded, and withdrawn.

The pleura lies on the inner side of the wound, the subclavian artery below. If the vertebral enters the fifth foramen instead of the sixth it generally runs slightly more to the inner side.

### Ligature of the Internal Mammary Artery.

The internal mammary runs downward behind the costal cartilages to the margin of the sternum in the sixth interspace, where it divides. At its origin it is crossed by the phrenic nerve and by the junction of the internal jugular and subclavian veins; in the first three interspaces ligature is fairly easy; after that, it becomes more and more difficult. The incision is oblique, with its centre corresponding to the middle of the intercostal space concerned; the skin, superficial fascia, aponeurosis of the pectoralis major, and the intercostal fascia are successively divided and the artery exposed, with a vein on either side. If there is not sufficient room, part of the costal cartilages or of the sternum should be removed as well.

### Ligature of the Axillary Artery.

The axillary artery is tied either on the front of the thorax in the first part of its course, or from the axilla in the third. The line of the vessel, when the arm is abducted from the side, is from the middle of the clavicle outward to the inner side of the prominence caused by the coraco-brachialis.

1. *In the First Part of its Course.*—The patient is placed on the back with the shoulder unsupported, hanging over the edge of a pillow, and the arm by the side. Later, after the muscle is divided, a greater amount of space can be obtained by pushing the elbow somewhat upward. Various incisions have been used, but the most simple is one running parallel to the clavicle, half an inch below it, from just inside the coracoid process to within an inch of the sternal end. The skin, superficial fascia, and some fibres of the platysma are divided; the clavicular portion of the pectoralis major is cut through in successive layers, any vessel that bleeds being clamped at once; and the costo-coracoid membrane exposed, with the cephalic vein crossing inward and the acromio-thoracic artery (some branches of which have already been divided) coming forward through it. The layer of fascia is cut through on a director, parallel to the clavicle, above the perforation of the cephalic vein, and the axillary sheath exposed, covered with a little loose fat. The sheath is opened above; the vein lies almost in front of the artery, but it can usually be pressed down with the finger out of harm's way. The needle should be passed from below upward, avoiding the long thoracic nerve which lies behind the artery on the serratus magnus, and the lowest cord of the brachial plexus, which lies immediately above.

This operation can readily be performed upon the dead subject, but it is very doubtful if, in the living, it has any advantage over ligature of the third part of the subclavian; and certainly it has several grave disadvantages. Its branches are numerous, the vein is seriously in the way, very large abnormal branches not unfrequently arise from it, and the operation is much more difficult.

2. *In the Third Part of its Course.*—The arm is abducted from the side and rotated outward to bring the folds of the axilla and the head of the bone into prominence. The line of the artery is parallel to the margins of the axilla, but nearer the anterior than the posterior. When operating on the left side, the surgeon stands between the arm and the thorax; on the right, it is more convenient for him to place himself on the outer side (Fig. 59).

The incision, three inches in length, runs down the inner border of the coraco-brachialis from the highest point of the axilla. The skin and superficial

fascia only are divided. The deep fascia is slit up on a director, the inner bo of the muscle defined, the median nerve which lies next to it (except the musc cutaneous which perforates it) pulled slightly to the outer side, and the ar exposed behind it. The sheath is opened in front and the needle passed fr within outward.

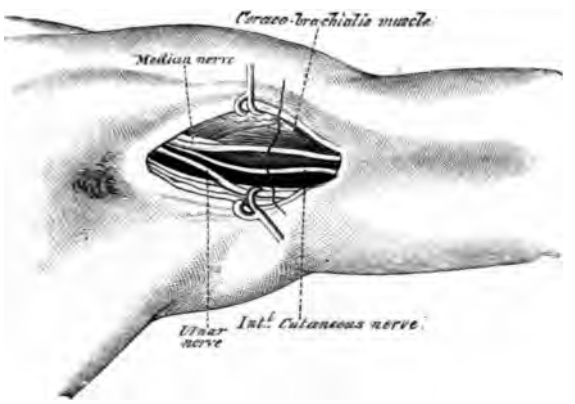


FIG. 59.—Ligature of Axillary Artery.

If the axillary vein is single and occupies the normal relation to the artery, may not be seen at all or only indistinctly through the sheath; but often there a two, and sometimes they lie on opposite sides and are united by transver branches across it. Abnormal branches are not at all uncommon, the radial, f example, arising high up.

### LIGATURE OF THE BRACHIAL ARTERY.

The brachial artery may be tied in any part of its course. The line is fro the inner margin of the coraco-brachialis in the axilla, down the inner margin the biceps to the middle of the bend of the elbow.

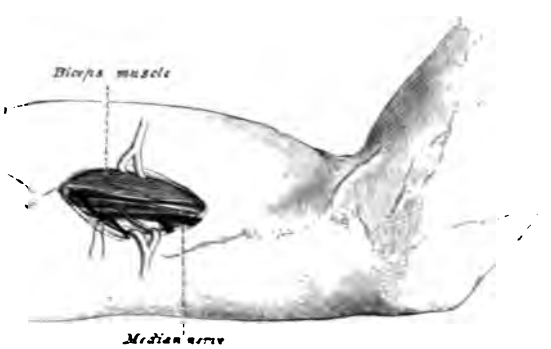


FIG. 60.—Ligature of Brachial Artery.

The arm is abducted, extended, and rotated outward. In the later step the operation, if the biceps overlaps the artery, the elbow may be flexed to rela (Fig. 60).

1. *In the Upper and Middle Part of its Course* an incision two inches l is made over the inner margin of the muscle, dividing the skin and the superfi

fascia only. The deep fascia is cut through upon a director, the muscle drawn outward, and the median nerve, which usually lies upon the anterior surface of the artery, drawn either outward or inward according to its position. The artery lies to the inner side of the muscle, with a vein on either side of it; and the needle may be passed in either direction. Occasionally the median nerve lies on the deep surface of the vessel, not the superficial, and sometimes a certain amount of difficulty arises from abnormalities, the brachial winding round the internal condyle of the humerus, or dividing into two branches high up. It is said that a large inferior profunda has been mistaken for the artery, and that difficulty has been caused by the median nerve resting upon the vessel and receiving an impulse from it.

The brachial artery may be compressed against the shaft of the humerus in any part of its course, the direction of the pressure varying with the part of the artery concerned. In many cases it is rather painful, probably owing to the fact that the nerves are pressed upon as well.

2. *Ligature at the Bend of the Elbow.*—The arm is abducted, the elbow extended and supinated. An incision an inch and a half in length is made obliquely at the bend of the elbow, parallel and close to the inner border of the tendon of the biceps, avoiding the median basilic vein, which lies to the inner side, and the median cephalic, which lies below. As it is deepened the median basilic vein can be drawn inward, and with it the internal cutaneous nerve. The strong semilunar fascia from the biceps is then divided upon a director, and the artery with its venæ

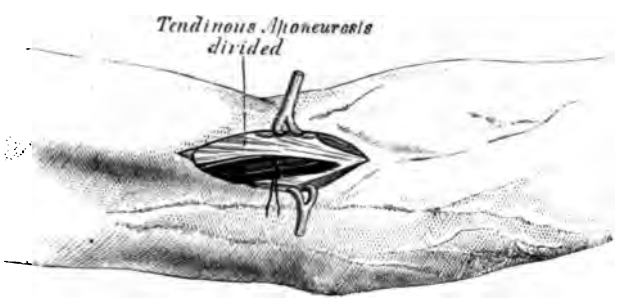


FIG. 61.—Ligature of Brachial Artery at the Bend of the Elbow.

comites exposed, lying surrounded by a small amount of cellular tissue and fat. The needle may be passed from either side, the median nerve being some little distance off (Fig. 61).

Forced flexion and forced extension can control and even stop the pulsation in the brachial at the elbow, the former by compressing it between muscular masses, the latter by the tension exerted on it.

## LIGATURE OF THE RADIAL ARTERY.

The line of the vessel is almost straight from the inner side of the tendon of the biceps to just internal to the base of the styloid process of the radius; it may be tied in any part of its course (Fig. 62).

The arm is extended and supinated; later, when the upper part of the artery is to be tied, the elbow joint is flexed to relax the supinator longus.

1. *In the Upper Part.*—The line of the incision varies with the condition of the muscles. When they are only moderately developed it may correspond to that of the artery; but in cases in which the prominence of the supinator longus reaches beyond the middle of the limb, it is placed more to the inner side. The skin and superficial fascia are divided for from two to three inches, avoiding as far as possible the large cutaneous veins often present in the course of the vessel; the deep fascia is cut through upon a director, the edge of the muscle raised (while the

elbow is flexed), and the under surface followed until the artery is exposed, surrounded by a little loose fascia and lying upon the pronator radii teres. The veins lie on either side of it, the nerve is not seen (Fig. 63).

2. *At the wrist* this artery is quite superficial, and all that is required is a very short incision on the radial side of the tendon of the flexor carpi radialis, between it and the supinator longus. The deep fascia must be very cautiously cut through upon a director. Two veins accompany the artery; the nerve lies adjacent to it for part of its course, but leaves it before it reaches the wrist (Fig. 64).

3. The radial artery may also be tied on the outer side of the wrist, where

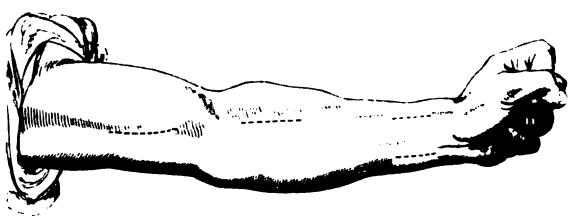

FIG. 62.—Line of Incision for Ligature.

its pulsation can easily be felt. The hand should be abducted and slightly extended to relax the extensor tendons of the thumb.

### LIGATURE OF THE ULNAR ARTERY.

The line of the ulnar artery extends from the inner side of the biceps tendon in the middle of the bend of the elbow, inward to about the middle of the ulna, and then straight down to the outer side of the pisiform bone. The arm is extended and the forearm supinated; but after the interval between the muscles is found the wrist is flexed to relax the stuctures on the front of the limb.

1. The artery can be tied in the upper third of its course, although it is difficult to understand what circumstances could give rise to such an operation. The line of incision is not that of the artery, it runs from the front of the internal condyle to the outer border of the pisiform bone, and is at least three inches in length. The skin and superficial fascia are divided, and the deep fascia thoroughly exposed in order to find the white line that marks the tendinous edge of the flexor carpi ulnaris. This is divided for the whole length of the wound; the hand is flexed to relax the muscle, and the fibres separated until the ulnar nerve is laid bare lying upon the flexor profundus. External to this is the edge of the flexor sublimis, which must be divided, and then carefully lifted up from the flexor profundus beneath, until the vessel is exposed with the veins on each side. Lower down, where it approaches the nerve, it is much more easy

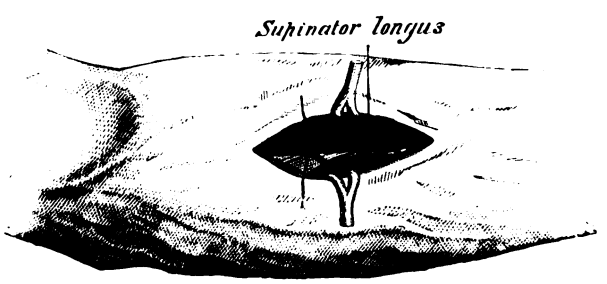


FIG. 63.—Ligature of Radial Artery.

2. At the wrist all that is required is a short incision along the radial side of the flexor carpi ulnaris tendon. As soon as this is exposed the wrist is flexed and the tendon raised with the handle of the scalpel, laying bare the deep fascia which covers in the artery as it lies upon the flexor profundus or the annular ligament. The nerve lies to the inner side, and is slightly deeper (Fig. 64).

### Ligature of the Abdominal Aorta.

The abdominal aorta divides opposite the left side of the body of the fourth lumbar vertebra, on a level with the umbilicus and the highest point of the crest of the ilium. The line of the iliac arteries runs from this to a point on Poupart's ligament, midway between the anterior superior spine of the ilium and the pubic symphysis. The upper third corresponds roughly to the common iliac, the lower two-thirds to the external.

The abdominal aorta has been tied ten times in all, one patient surviving ten days after the operation. Cooper's incision was in the middle line of the abdomen, the intestines being pushed on one side and the peritoneum scratched through with the finger nail. The other method is post-peritoneal, the incision being similar to that employed for ligature of the common iliac, but prolonged at least as high as the umbilicus. The needle should be passed from left to right.

Compression of the abdominal aorta is easily managed at the umbilicus by

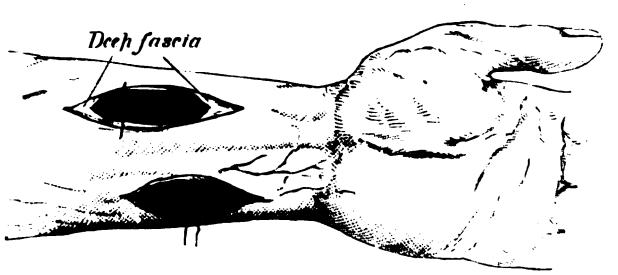


Fig. 64.—Ligature of the Radial and Ulnar Arteries.

means of Lister's tourniquet, and may be kept up under an anæsthetic for an hour and more without any serious consequences. In thin people the artery may be controlled with the thumbs. The tourniquet should be placed upon the right side and with the upper pad rather beyond the middle line, as the aorta lies on the left.

### Ligature of the Common Iliac.

Abernethy's incision for ligature of the external iliac commences one inch above Poupart's ligament, half an inch outside the external abdominal ring, runs upward curving round parallel to Poupart's ligament, and terminates a short distance above and internal to the anterior superior spine. How far it should be prolonged upward in a case of ligature of the common iliac depends upon the condition of the abdominal wall. Certainly it must be continued at least two inches above the anterior spine, and not unfrequently as high as the umbilicus (Fig. 65). The skin and superficial fascia are divided first; then the external oblique, internal oblique, and transversalis muscle in order (some of the branches of the circumflex ilii being cut between the two last) and the transversalis fascia exposed. This can always be distinguished from the peritoneum by its being attached to Poupart's ligament. A small incision is carefully made in it, at the lower angle of the wound, where it is thickest, and where the sub-peritoneal fat collects most, and then it is divided for the whole length upon a broad, flat director. The peritoneum is pushed inward, not stripped up, the patient being turned over slightly

to the opposite side, the sheath of the artery exposed and cleaned, and the needle passed round it from within outward. The spermatic vessels and the ureter adhere to the peritoneum and so escape danger.

On the left side the veins do not give much trouble; the left common iliac lies to the inner side of the artery the whole way. On the right, however, the relation is much closer. The inferior vena cava begins on the right side of the artery, over the body of the fifth lumbar vertebra; the left common iliac passes behind the commencement; the right behind the end, winding round as it ascends until it comes to lie upon the outer side. As the artery cannot be seen the difficulty can easily be imagined.

The operation has been performed according to Lidell sixty-eight times with only sixteen recoveries, and it is a matter of question whether it would not be advisable to adopt Cooper's method and—especially if it is the right side—deliberately open the abdomen.

The common iliac arteries can be controlled at their point of bifurcation by means of Davy's lever. It is simply a smooth, straight bar of wood, which is introduced through the anus and passed up the bowel until it rises out of the cavity of

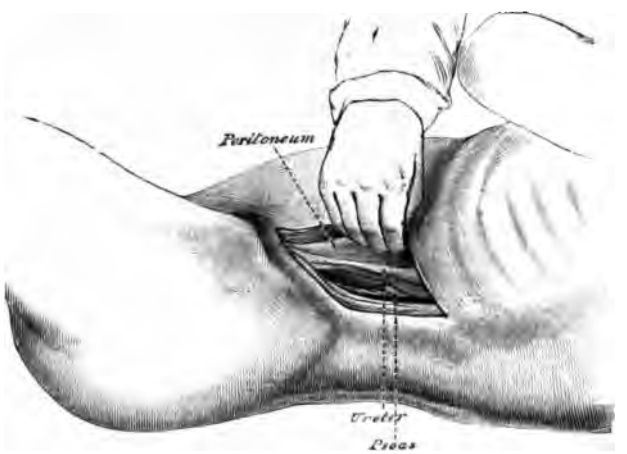


FIG. 65.—Incision for the Application of Ligature to the Aorta or Common Iliac Artery.

the true pelvis. By raising the outer end and turning it to one side or the other, the opposite artery is easily compressed against the bone, just at or above its bifurcation. It controls the branches of the internal as well as of the external iliac, but it is in many cases very difficult of introduction; when a large, loose rectum falls into folds it is sometimes no easy matter for the hand to find its way up; perforation has been caused by it, and the mucous membrane of the bowel is liable to slough if the pressure is continued.

### LIGATURE OF THE INTERNAL ILIAC.

The position of the patient and the line of the incision are the same as for ligature of the common trunk. The peritoneum must be pushed inward in the same way, and the finger passed down over the external branch to find the internal. The needle is passed from within outward, the internal iliac vein lying behind it and to its inner side, the termination of the external and the commencement of the common behind, and to the outer side at its origin. There is usually a little

### Ligature of the Gluteal Artery.

The line of the gluteal artery extends from the posterior superior spine of the ilium to the apex of the great trochanter; it emerges from the pelvis at the junction of the upper with the middle third. The position of the patient is face downward with the thigh extended.

The incision is in the line of the artery, four inches in length. The skin and superficial fascia are divided, the fibres of the gluteus maximus exposed and separated, and the upper margin of the great sacro-sciatic foramen felt for with the finger. The artery emerges through this between the margins of the pyriformis and the gluteus medius.

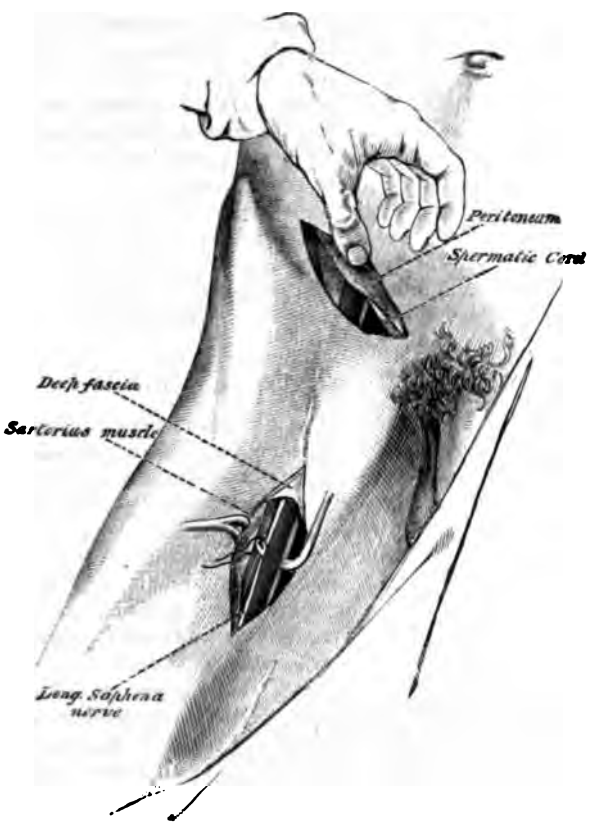


Fig. 66.—Ligature of External Iliac and Superficial Femoral Arteries. In this figure the incision for the Femoral Artery is placed too low.

The spot at which the sciatic artery is found lies internal to and below this, in the middle of the line drawn from the posterior superior spine to the tuberosity; the incision is vertical.

The internal pudic lies about half an inch internal to this, under the cover of the great sacro-sciatic ligament.

### Ligature of the External Iliac.

The line of the artery is the continuation of that for the common iliac; exceptionally in old people with tortuous vessels it is thrown into curves, the most marked of which usually dips down into the pelvis. The position of the patient is the same, the limb being extended and slightly abducted.

There are two methods—Abernethy's, which has been described already, and

Cooper's (Fig. 66). The incision in the latter is s
half an inch above Poupart's ligament, commencing
and running toward the anterior superior spine for
superficial fascia, and a few small vessels passing
divided; the aponeurosis of the external oblique is
upon a director; the internal oblique and transvers
outward, or if necessary divided to a slight extent, a
the internal abdominal ring and the spermatic cord
artery and the cord are then pulled upward and i
cautiously divided sufficiently to admit the finger,
exposed, overlapped to a very slight extent by th
passed from the side of the vein, taking care not to i

Cooper's operation, there is no doubt, interfe
abdominal wall less than Abernethy's, although, if
the layers carefully united to each other in their
slightly in either. The peritoneum is less exposed
of being injured, but the difference is not a mater
on the other hand, is distinctly in very great dange
circumflex ilii vein almost crosses the seat of ligatu
artery is diseased, it is impossible to reach the uppe
without enlarging the wound very seriously. Al
preferred for all cases except aneurysms situated belo
the artery can be shown to be healthy where it cros

### Ligature of the Femoral

The line of the artery begins at the mid-point
and the anterior superior spine, and when the li
the inner border of the patella, the vessel extendi
If, on the other hand, the limb is flexed, abducted, a
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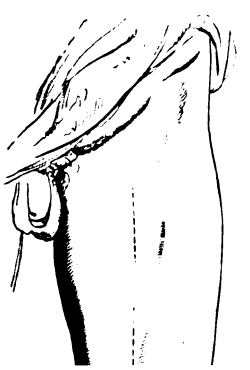

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2. *The Superficial Femoral in Scarpa's Triangle.*—The point selected is at the apex, just before it is crossed by the sartorius, usually four or five inches below the ligament and two or three below the origin of the profunda.

The limb is slightly flexed, abducted, and laid upon its outer side, the line of the artery marked out (if possible the pulsation should be felt), and the course of the internal saphena vein ascertained. The incision is three inches in length, with its centre opposite the point selected. The skin and superficial fascia are divided, the fascia lata exposed, and the edge of the sartorius made out as it runs downward and inward past the lower margin of the wound. The fascia is divided along the edge of the muscle, which is then drawn outward and raised with a retractor; another thinner layer cut through beneath, and the sheath of the vessel exposed, with perhaps the internal cutaneous nerve crossing it. A small opening is made in the sheath and the needle passed round the artery from within outward, care being taken not to injure the vein which lies almost immediately behind.

3. *The Superficial Femoral in Hunter's Canal.*—Hunter's canal occupies the middle third of the thigh measured upon the inner side; the point selected for ligature is in the middle of this or midway between the groin and the knee. The line of the incision, when the limb is flexed, abducted, and rotated outward, is a finger's breadth internal to the line of the artery, and should be three or four inches in length.

The skin and superficial fascia are divided, avoiding the internal saphena vein, and exposing the fascia lata covering the sartorius. The muscle is recognized by the almost vertical direction of the fibres. The fascia is divided upon a director along its outer or anterior border, the muscle pulled inward with a retractor, and the fibrous tissue forming the roof of Hunter's canal and stretching from the vastus internus to the adductors exposed. The aponeurosis is slit up on a director, some branches of the anastomotica perhaps being divided at the inferior angle, the sheath of the vessel exposed, with the long saphenous nerve lying upon it just before it perforates the adductor magnus, a small opening made in it, and the needle passed from without inward, the vein lying to the outer side and slightly behind.

### Ligature of the Popliteal Artery.

The popliteal extends from the opening in the adductor magnus to the level of the tubercle of the tibia. It may be tied in the upper or in the lower part of its course.

1. *In the Upper Part.*—The position of the limb should be the same as for ligature of the femoral in Hunter's canal, with the knee flexed. The operator stands on the outer side. An incision three inches in length is made immediately behind the tendon of the adductor magnus, commencing or ending, as the case may be, opposite the adductor tubercle. The skin and superficial fascia are divided, taking care not to cut the internal saphena vein, and the fascia lata separated from the anterior margin of the sartorious, some of the branches of the anastomotica probably requiring to be twisted or clamped. The adductor tendon is drawn forward, the sartorius and the inner hamstrings backward (the long saphenous nerve will probably follow the adductor tendon, and with it the main superficial branch of the anastomotica), and search made with the finger and a director in the fat that protrudes. The depth of the artery varies according to the distance down the limb; the vein is not seen at all.

2. *In the Lower Part.*—The patient lies upon the face, or in what is known as the three-quarter prone position, with the knee at first extended. Afterward it may be bent to relax the gastrocnemius if it is required. The incision is vertical, three inches in length in the line of the vessel and outside the external saphena vein if this is seen. The skin, superficial fascia, and deep fascia are divided successively, the internal popliteal nerve pulled outward, the semi-membranous inward if it is exposed, and the dissection carried very carefully through the loose fat that

;th is made behind and below the internal malleolus, the pulsation of the el being the best guide. The deep fascia here is thicker still, forming the internal annular ligament that binds the tendons down. Care should be taken not to open any of the synovial sheaths (Fig. 70).

. 70.—Ligature of the Posterior Tibial Artery Behind the Internal Malleolus.

FIG. 71.—Line of Incision for Ligature of the Anterior Tibial.

### LIGATURE OF THE ANTERIOR TIBIAL.

The artery extends from a point midway between the head of the fibula and ıe external tuberosity of the tibia to another which lies midway between the two alleoli, and from thence to the base of the space between the two first metatarl bones. At first it is very deep; lower down its pulsation can be easily felt. he leg is extended and the foot held in position of the plantar flexion (Fig. 71).

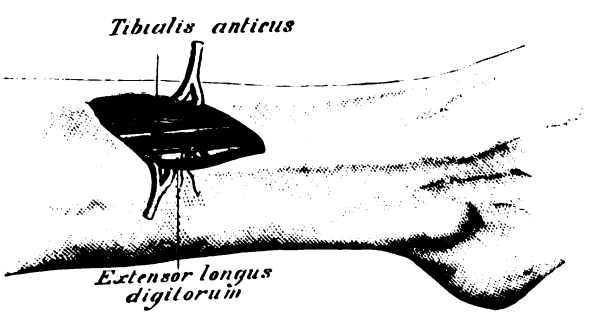


FIG. 72.—Ligature of the Anterior Tibial Artery.

1. *In the Upper Third.*—An incision from three to four inches in length is ade in the line of the artery and deepened until the deep fascia is reached. If e separation between the extensor communis digitorum and the tibialis anticus annot be seen when the foot is bent upward, a transverse or oblique cut is made rough the aponeurosis. The line of division then is usually evident at once. he two muscles are separated with the handle of a scalpel, and the artery is found ing with the nerve superficial to it and a vein on each side.

2. *In the Lower Part of the Leg.*—The incision is three inches in length the line of the artery. The skin and superficial fascia are divided, and care search made with the finger for the g between the extensor hallucis and th common extensor. If this is found th aponeurosis is slit up on a director, and search made under the former of the two; even a short distance above the ankle joint the tendon often has not yet crossed to the inner side. If there is no indication the fascia is slit up in the same way, and all the structures that lie on the inner side pulled outward away from the tibia with the fore-finger; the innermost cord, which consists of the tibialis anticus and the extensor hallucis, is now allowed to slip back and search made for the vessel next to it. The nerve lies upon the outer side (Fig. 72).

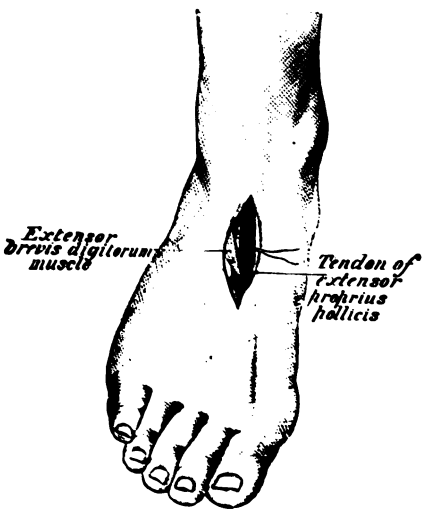


Fig. 73.—Ligature of Dorsalis Pedis Artery.

3. *The Dorsalis Pedis.*—The guide to the artery is the inner slip of the extensor brevis digitorum. The incision is made over this in the line of the vessel, the tendon drawn to one side, and search made beneath (Fig. 73).

# CHAPTER III.

## *INJURIES AND DISEASES OF THE LYMPHATICS.*

## INJURIES OF LYMPHATICS.

The lymphatics are so widely distributed that they must be severed or torn in every cut or bruise to a greater or less extent; but as a rule they collapse at once and give no trouble. Persistent escape or collection of lymph, unless there is some obstruction higher up, causing œdema of the part, is very rare; but probably a great deal of the early discharge from wounds comes from the divided lymphatics, and certainly the poisons that cause the various kinds of wound fever (septic and traumatic), are chiefly absorbed through them.

The thoracic duct has occasionally been wounded, leading to the discharge through a fistulous opening of a spontaneously coagulating liquid, milky during digestion; and in one case its opening is stated to have healed under a plug. In another instance the duct was ruptured opposite a fracture of the spine, and the contents were poured out into the pleural cavity, compressing the lung and ultimately causing death.

## DISEASES OF LYMPHATICS.

### Lymphangitis.

Acute inflammation of the lymphatic vessels is always secondary, and is usually caused by the entrance of an irritant poison through the connective-tissue rootlets. Exceptionally it follows sprains, or the inflammation spreads from surrounding structures and involves the wall directly. In most cases the immediate source is a poisoned wound, often a mere pin-prick or scratch, sometimes so small that it is overlooked altogether; and consequently it is of frequent occurrence among butchers, cooks, and those engaged in post-mortem work. In the case of the throat it may perhaps originate without an abrasion, the poison entering through the spaces between the epithelial cell; but naturally this is incapable of proof. Recent wounds are much more likely to be attacked than granulating ones, and those which are not kept at rest or in which there is any discharge confined under high tension, and above all, pustules, are the most likely of all.

Whatever the irritant may be, it probably does not cause inflammation of the wall of the vessel unless it is arrested by clotting. If this does not take place, it is hurried on to the neighboring lymphatic glands, and sets up inflammation there.

**Pathology.**—The changes are best seen in larger trunks. The delicate cellular tissue that surrounds the vessel and forms its outer wall is swollen, softened, and congested; the intima becomes cloudy, the endothelial plates lose their distinctness of outline, and the lymph that fills the vessel and the plasma that circulates through and around its walls coagulate. They are no longer in contact with healthy structures. Outside the vessel altogether, some distance away from the irritant, the blood-vessels dilate, and the blood and the plasma circulate more rapidly and in greater quantity; immediately around the exciting cause, the stream either ceases or is carried on very slowly, and the lumen of the vessel, the interstices in its wall, and the cellular sheath become filled with a coagulating exudation.

The future course, whether resolution, organization, or suppuration sets in, depends upon the cause. Resolution begins at once, if the irritant is slight and transient; the fibrin disappears, the walls of the vessel recover, the endothelium is regenerated, and the circulation is re-established. Organization is probable if its

action is persistent, as in syphilis; and the coats of the vessels, and the cellular tissue in which they lie, become hard, dense, and sclerosed. Suppuration only takes place when pyogenic micro-organisms are the exciting cause, coagulation-necrosis setting in, and the solid tissues becoming liquefied and melting away. As a rule it is circumscribed, but if the tissues are badly nourished from intemperance or starvation, or if there is septic decomposition as well to assist, it may be diffuse and boundless.

**Symptoms.**—These are plainest when the superficial vessels are involved. Red lines mark out their course upon the skin—wavy, irregular, very tender to the touch, slightly raised above the surface, and hardened from thrombosis. Sometimes they are quite narrow; sometimes, when the poison is very active, an inch or more in breadth. At the same time the glands are swollen and tender, and if the affection is extensive the limb below may be œdematous. With the deeper trunks most of these signs naturally are wanting; but usually, even in the deepest, faintly outlined patches of redness are visible here and there upon the skin, where the superficial plexuses communicate with the deep ones.

A rigor is not uncommon at the beginning, and if the inflammation is widely spread there may be a very considerable degree of fever and prostration. Simple lymphangitis is rarely serious; if, however, suppuration sets in it may be attended by very grave illness, and if the vessels (which run in groups) are extensively destroyed, a condition of solid œdema is very likely to persist, leaving the limb more or less crippled. When it occurs as part of a diffuse inflammation of the cellular tissue its significance is, of course, altogether different; it is part then of a general suppurative infection, not unlikely to end in pyæmia, the chief safeguard against the constitutional affection spreading through the lymphatics being the arrest of the pyogenic micrococci in the neighboring glands.

**Treatment.**—The cause should be removed at once or rendered innocuous by the free use of antiseptics; tension immediately relieved by incision, drainage, warmth, or other measures, as the case requires; absolute rest enforced; and the limb raised to diminish the amount of blood entering it as well as to facilitate the return of the lymph. Cold evaporating lead lotion is the best local application. Quinine may be given internally if the temperature is high; and the bowels usually require to be opened.

If suppuration occurs the abscess should be incised at once. Afterward, when the inflammation has subsided and the wound healed, if there is any œdema left it may be relieved, if not cured, by the proper application of massage and bandaging.

### Lymphadenitis.

Inflammation of lymphatic glands always accompanies inflammation of the vessels; but in a very much larger number of instances it occurs independently of them, the irritant having been carried along by the lymph stream without causing any symptoms until arrested in the gland. It may be *simple* (*acute*, ending in resolution or suppuration, and *chronic*) or *specific*, as in tubercle, syphilis, glanders and perhaps some chancroids.

#### I. *Simple Adenitis or Bubo.*

The pathological changes are similar to those that occur in inflammation elsewhere. The cortex is the part first involved; it becomes more vascular, soft, and swollen; the lymph-paths are filled; the corpuscles are packed in the follicles as tightly as they can be; the reticulum loses its distinctness; and here and there where stasis occurs and the capillaries give way, masses of red blood-corpuscles can be seen. In recent acute cases the gland is a deep purple throughout, and the connective tissue around is swollen and infiltrated with lymph almost to the same extent. This may terminate in *resolution;* or the inflammation may become

*a. Resolution.*—The process is exceedingly simple; the hyperæmia diminishes; the excess of lymph-corpuscles is gradually removed; the lymph-paths are opened up again; old extravasations are quietly absorbed; and the whole gland resumes, or nearly so, its normal condition. A certain degree of enlargement is very commonly left, especially if the attack is repeated.

*b. Chronic Inflammation.*—This termination is almost as common. The cellular exudation, instead of being absorbed or undergoing fatty degeneration, becomes organized; the capsule is thickened, hard, and adherent to the structures round; the adenoid tissue of the follicles is indurated; and occasionally, when the glands are extensively involved, the circulation is seriously impeded, leading to dilatation of the lymphatics and even solid œdema in the parts below.

*c. Suppuration.*—This may begin either in the gland itself, yellow foci of coagulation-necrosis occurring in the various parts of the cortex and enlarging until they fuse; or more generally as periadenitis. In the latter case, when the abscess is opened, the gland is found lying in a more or less sloughing condition, attached to one side of the cavity. Residual abscesses are of common occurrence in connection with lymphatic glands; inflammation subsiding and remaining quiet perhaps for years, and then, from some slight additional irritant, suddenly breaking out again and running on to suppuration.

**Causes.**—A moderately acute form of inflammation not unfrequently follows over-exertion or exposure to cold, especially if there has been at any time a previous attack. The glands become swollen and painful; the skin over them is tender on pressure; the neighboring muscles are stiff, and movement is much restricted. As a rule, this subsides without any serious result as soon as the cause ceases to act; its importance is due to the fact that the tissues, enfeebled by inflammation, form the most suitable soil for the development of any germs that may reach them. Suppuration may occur, especially in those whose health is broken down; tubercular disease may follow; I have known it to develop rapidly in the femoral glands after a strain in jumping; and in children it is probable this often happens. The eruption of the teeth, for example, is attended with a considerable degree of enlargement and some inflammation of the submaxillary glands. In most cases this subsides of itself as soon as the parts become quiet again, but occasionally it forms the starting point for suppuration or tubercular disease, the micrococci or bacilli, as the case may be, gaining access to the damaged tissue through the mucous membrane of the mouth. When the glands are healthy these germs are practically inert.

Acute inflammation of the glands arises from the same causes as acute lymphangitis, especially poisoned wounds in which there is friction or tension to facilitate absorption. In rare cases it is said that there is no breach of surface, but it is proverbially impossible to prove a negative. Specific forms of inflammation can only arise from specific causes, and these are rarely limited to the gland first involved; tubercle, syphilis, glanders, etc., all tend to spread from one to another, although there may be at first a temporary arrest. This is not so with the micrococci of suppuration. Against these the adenoid tissue seems to possess an unusual power of resistance; not only does the mischief rarely extend beyond the glands first attacked, but these themselves appear capable of holding out for an exceptionally long period. Inflamed glands are exceedingly common as the result of gonorrhœa, soft sores, pustules, poisoned wounds, and many other injuries; but although, of course, many instances do occur, suppuration is by no means invariable. The pyogenic micrococci must be carried to the glands in abundance by the lymph corpuscles and the lymph stream; but if the adenoid tissue is fairly well nourished, and protected from injury, in many cases they are only able to excite a certain degree of inflammation.

Chronic adenitis, if not of specific origin, usually results from the frequent repetition of acute attacks. The glands are left slightly enlarged, hardened, and infiltrated with fibrous tissue; and they may persist in this condition without

change and without causing any symptoms for years. In many instances it impossible to say how far this is due to syphilis.

**Symptoms.**—When the attack is acute, and the gland is tightly bo down by fascia, the symptoms are severe. On the other hand, if there is a l amount of loose cellular tissue around, so that there is but little tension, they m be very slight; in the axilla even suppuration may occur without the patient co plaining of it. Pain, heat, and swelling are the most prominent; the first e cially, when the deeper glands are involved; the last when the structures round soft and yielding. Tenderness on pressure is always present; and if the gland c be felt, it is fixed in its bed, partly from its size, partly from the cellular exu tion around binding it down. The constitutional disturbance, like the pa depends largely upon the tension; in the slighter cases it is scarcely noticeable in the more acute ones, especially when the deep glands are inflamed, it is oft very marked.

Suppuration may begin very quietly when the tissues around are loose an yielding, or there may be high fever and even a rigor. The part begins to throb the skin is red, glazed, and œdematous, the swelling rapidly increases in size, and the outline becomes ill-defined. If the pus forms in the interior fluctuation is often very indistinct; if around the gland it may be apparent almost at once.

There is rarely any difficulty in the diagnosis of acute inflammation; the locality, the nodular character of the swelling, and the evidence of an exciting cause (which may, however, have already disappeared) indicate at once the structure concerned. Chronic enlargement is more difficult, especially in the groin, where it is easily mistaken for epiplocele and *vice versa*. The shape of the swelling, the direction it takes, and the fact that it is rarely single, but nearly always involves the neighboring glands, are the most important distinctions. The question of suppuration is very difficult; in a large proportion of cases it is practically impossible to say, without exploration, whether it has commenced or not.

**Treatment.**—The exciting cause should, if possible, be removed at once. Absolute rest, cold, uniform compression, and elevation are the most effectual measures for preventing suppuration; heat and counter-irritants only encourage it. When pus forms the shortest way is to open up the abscess freely, allow the contents to escape of themselves, and apply boracic fomentations, with a considerable degree of pressure, in order to keep the surfaces at rest. If the gland has been destroyed and remains adherent to the inner surface of the abscess it should be removed at the time of the operation. In the groin, if the redness and œdema are very well defined, showing that there is not much infiltration of the cellular tissue round, two punctures with a drainage-tube or a bundle of horse-hair passed across may succeed, and in very slight cases even a single one; but unless the patient is kept in bed with such an amount of dressing on that the limb is practically fixed it is very likely to end in the formation of a chronic sinus.

### II. *Tubercular Adenitis.*

The lymphatic glands are one of the most common seats of tubercular disease. The bacilli enter through the mucous membrane of the respiratory or alimentary canal, or through the skin (after wounds, abrasions, attacks of eczema and the like), and at once, if there is the least predisposition, or if the resistance of the tissues is lowered by inflammation, lead to the deposit of miliary tubercle. In a few cases infection may take place through the blood. No glands in the body are exempt; but naturally those in certain localities—the neck, the mesentery, and the mediastina—are more often affected than others, and it may occur at any age, although it is by far the most common in children and during young adult life.

**Pathology.**—The changes are characteristic; gray miliary nodules develop usually in the centre of the adenoid masses, with typical giant and epithelioid cells, and outside these an infiltration of smaller ones, lying in a zone of hyper

anæmia, and caseation soon begins in the middle. Several of these small nodules form near each other and fuse, so that when the gland is cut across there is a dead white caseous spot surrounded by a soft, pinkish gray areola. Gradually, as these increase and multiply, fresh tubercles forming round their margin, the whole gland becomes enlarged. the capsule grows thicker, partly from the irritation and tension to which it is subjected, partly from the condensation on it of the loose cellular tissue around, and at length, if it is cut across when the disease is advanced, the only trace of normal adenoid tissue left is a thin layer immediately under the capsule; the whole of the rest is converted into a dense white caseous mass, many times the size of the original gland, but still showing its origin by its shape and by the relation it bears to the trabeculæ.

The subsequent changes are the same as those that occur elsewhere. If the tubercle-bacilli spread and the whole gland becomes involved, the central portion breaks down into a greenish-yellow puriform fluid, the surrounding cellular tissue is invaded through the hilum, and suppuration follows, forming an irregularly-shaped abscess (often extending long distances under the fascia) with the remains of a lymphatic gland, consisting chiefly of the capsule lined with caseating tubercle, still adherent to one part of the wall. If, on the other hand, they perish, either calcification or fibroid induration, or both together, follow.

**Symptoms.**—The characteristic feature is a chronic, painless enlargement, affecting usually several glands in the same locality, although often one more than the rest. At first they are freely movable, but, after a time, they become matted together and adherent to the surrounding structures. Later, after a very variable period, softening may occur, the swelling enlarges in size and becomes more ill-defined, the skin becomes reddened at one point, grows thinner and thinner, and finally gives way, leading to the discharge of a thin oily pus, mixed with caseous debris, and leaving a sinus which nearly always pursues a most irregular and devious course. Healing, if these cases are left to themselves, is always very protracted; the growth of the tubercle must cease, the whole of the caseous material come away, and the sinus close from the bottom, and as the skin is usually undermined in all directions, and it is exceedingly difficult to keep the parts at rest, it may be many years before it is complete.

General infection from superficial caseating glands is rare, although it may take place from mediastinal ones. Local recurrence again and again is not uncommon; but at length, in the vast majority of cases, the patient lives down the bacillus and recovers, bearing the traces of his illness in the deep seams and cicatrices left.

**Treatment.**—The constitutional treatment of tubercular adenitis is of the greatest importance: sea air, tonics, cod-liver oil, good feeding, and careful protection against cold, exposure, and irritants of all kinds. In many instances the balance between caseation and liquefaction on the one hand, and absorption and organization on the other, turns entirely upon this.

The local treatment depends largely upon the amount of inflammation present and the number of glands involved. If there are only two or three and they are perfectly quiet and painless, without any evidence of adhesion to the tissues round them, they should be left altogether alone, or the skin may be thickly covered over with ung. plumbi iodidi and oiled silk at night. Rubbing and counter-irritants, such as tincture of iodine, are only too likely to precipitate an acute attack. If in spite of this the enlargement continues to increase, or signs of softening or of inflammatory adhesion begin to appear, excision may be performed, provided there is a reasonable hope of removing the whole; either caseation has taken place already in spite of all that has been done to check it, or it will very shortly, and undoubtedly the best and most effectual method, when the disease is limited and superficial, is free removal. It leaves a linear cicatrix in a situation chosen because it is concealed, and the wound is sound within a week, in place of a sinus that may continue to discharge for years, and invariably causes a depressed, seamed, and irregular scar. Even when the skin is involved the same plan may be tried

with success. It must always be remembered, however, that the real number of the glands concerned is probably far in excess of the apparent, and that removal of the more superficial ones is very likely to expose many more that lie deeper. The operator, therefore, must always be prepared, as unless the whole affected area is cleared little good is likely to result. Even such extreme measures as division of the sterno-mastoid and dissecting out the great vessels and nerves of the neck have been recommended.

If softening and suppuration have already taken place the actual cautery may be used to perforate the inflamed structures and destroy the interior of the gland, or it may be freely incised, the interior thoroughly scraped out with Volkmann's spoon, and packed with iodoform. Unhappily, in most cases the number of glands involved precludes anything like radical treatment of this kind; and all that can be done is to open any abscesses that are pointing; slit up or enlarge and drain any devious sinuses running beneath the fascia, scrape out all the caseous debris that is accessible; and try by means of constitutional treatment to improve the general health, so that cicatrization may take place.

FIG. 74.—Treves' Cervical Splint.

It not uncommonly happens in the neck that chronic sinuses with purple overhanging edges are left for years similar to those met with in the groin. In many cases these can only be cured by cutting away all the overhanging tissue, scraping out the interior, thoroughly stimulating the base and making the route direct. Hilton, however, has shown what it is possible to do to these by the judicious application of trusses in the groin; that the chief reason of failure of union is the perpetual motion to which the part is subjected; and that repair can take place even in advanced cases, if absolute rest is enforced; and Treves has strongly advocated the same thing in the neck. There is no doubt that, although the presence of caseous gland tissue and the indirect burrowing under the fascia have much to do with the delayed union and unsightly cicatrices so common after tubercular adenitis, want of rest is almost if not quite as important; and in every case in which this cannot be ensured in other ways some appliance, such as Treves' splint or a gutta-percha stock, should be used after operations.

### LYMPHATIC GLANDULAR TUMORS.

All forms of carcinoma and many of sarcoma involve the lymphatic glands sooner or later; these, however, are secondary growths, and derive their significance entirely from the primary one elsewhere. In addition there are others which originate in the glands themselves.

Primary lymphatic glandular tumors form an exceedingly difficult group; it is impossible to classify them satisfactorily either by their pathological structure or their clinical history. Microscopical examination fails to show any definite distinction between normal gland tissue, inflammatory hypertrophy, simple tumors or malignant ones; and clinical symptoms are no more successful, at any rate

the earlier stages when the diagnosis is of importance. Certain varieties that are fairly well characterized can be described; the rest must be grouped round them, nearer or further away, according to the sum of the features they present.

## I. *Lymphoma.*

This name is given to a perfectly simple form of overgrowth affecting one or, at the most, two or three glands in one part of the body. As such, it is decidedly rare (Fig. 75).

No cause is known; the gland steadily but persistently increases in size without undergoing the least change in structure. It is not inflamed or painful; it does not contract adhesions to the parts around; it does not degenerate or decay in any way; and it is not attended with any form of cachexia. On section it is absolutely normal, or at the most slightly lighter in color than the other glands. It may attain a fair size and cause considerable annoyance, but it is seldom very large.

FIG. 75.—Lymphoma, from the Cervical Glands.

Lymphatic glandular tumors answering this description are certainly exceptional. In the vast majority of instances, if they are excised (the only treatment suitable for them) and divided in two, it is found either that they contain a caseous focus in the middle, or that, without any change visible to the naked eye, they are full of miliary tubercles; in other words, that they are really examples of tubercular adenitis, which from some unknown cause, possibly an unusual power of resistance on the part of the patient, have followed an unusual course; the tubercles have continued to increase, but the lymphatic tissue has increased at a faster rate, without sufficient inflammation to make the capsule contract adhesions. In other cases it is probable that they are really the beginning of lymphadenoma, for sometimes, if they are left, they suddenly change their character and begin to grow rapidly.

## II. *Lymphadenoma.*

Two forms of this are described by some, according to whether leukæmia is present or not; but, as it is impossible to say upon what this depends, why it should occur in one case and not in another, it does not seem a sufficient reason for separating them. It is sometimes known as Hodgkin's disease or malignant lymphoma.

The pathological changes that occur in the glands in the earlier stages are identical with those met with in lymphoma or in chronic inflammation. In some instances the adenoid tissue is in excess and the glands are soft and juicy; in others there is a large amount of fibrous tissue, the size is smaller, and the consistence firmer. The difference, however, does not appear to be anything more than a physical one; clinically the two forms are precisely alike.

Lymphadenoma, at its commencement, may be confined to the lymphatic glands; or it may occur in the spleen before the glands are involved; and deposits of adenoid tissue, which, however, may be secondary, are not uncommonly found in the alimentary canal, the liver, kidneys, the medulla of bone, and elsewhere. It is evidently, therefore, a disease of an entirely different character from true lymphoma; but when it is primarily glandular, it may be impossible to distinguish one from the other, until, by the appearance of secondary growths, it is too late. Nothing is known with regard to its etiology: it is most common in young adult

### Lymphangeiectasis and Lymphangeioma.

The lymphatics are liable to dilatation and distention in the same way as the capillaries and veins. Sometimes this is congenital, like nævus, sometimes it is caused by obstruction. The minor form, affecting especially the smaller vessels, is known as lymphangeiectasis, the more pronounced as lymphangeioma.

#### I. *Congenital Dilatation.*

This may appear under various shapes. In the simplest there is merely an irregular expansion of the lymphatic vessels, generally in the skin, forming ampullæ and cavities of various sizes, lined with the characteristic endothelium. In those that are more severe the dilatation is greater, the partition walls between the cavities are thinner, so that they break down, and enormous, irregularly branching spaces are formed, sometimes spreading among the deeper structures to a distance of which the outside appearance gives no conception.

The most exaggerated form of the *cavernous lymphangeioma* is known as *hydrocele of the neck*, *congenital cystic tumor*, or simply *hygroma*. It may be present at birth, or it may be so small that at that time it does not attract attention, and then later, when it begins to enlarge, it may be mistaken for an acquired growth. The most common situation for it is the neck, but it may occur in the axilla or the back, or even in the region of the kidney. Sometimes it is apparently a single cyst, extending an enormous distance under the fascia; more frequently it is polycystic with cavities of all sizes, in some of which the fluid is clear and watery, in others greenish, and in others again distinctly and perhaps deeply blood-stained. The favorite locality is the posterior triangle of the neck, or just behind the angle of the jaw, whence they may extend into the mouth, over to the opposite side of the body in front or behind the trachea, down into the thorax, or, in short, almost everywhere. The walls vary in strength, though never very thick. Occasionally they contain here and there portions of nævoid tissue, which can be detected when superficial by the bluish tint they give. Much more rarely there is a considerable amount of solid growth, so as even to give rise to the suggestion of sarcoma (Fig. 76).

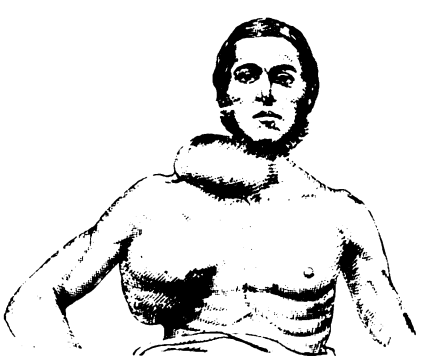

Fig. 76.—Serous Cyst of the Neck. (Birkett's case.)

A similar pathological condition probably underlies macroglossia, macrocheilia, and some at least of the varieties of congenital overgrowth of the limbs. Whether the enlargement of the breast, which, though not congenital, sometimes develops at puberty, is to be attributed to the same cause is uncertain. It appears at least to affect only the cellular-tissue elements of the gland, not the secreting structure.

The treatment of any of these congenital affections requires to be carried out very circumspectly. Single cysts may be tapped, and, if they refill, injected with iodine or with Morton's fluid. Larger ones may be drained, or a seton passed through them, but it must be remembered that very often they have very deep connections, and that if suppuration occurs the fever that follows is likely to prove exceedingly serious or even fatal. Polycystic growths may be drained seriatim, a deeper part being opened only when the superficial has contracted to a sinus. Excision is rarely practicable.

In cases of congenital giant growth, if the size is excessive, or if sarcomata develop from the imperfectly organized tissues, as sometimes occurs later in life, amputation is the only resource. Macroglossia and macrocheilia, when they are

small, can sometimes be kept in check by astringents, but usually inflammato hypertrophy is added to the congenital form, and the only hope is partial excisio

## II. *Obstructive Dilatation.*

Long-continued obstruction to the lymphatics causes a certain degree o varicosity similar to that which occurs in the veins, only much more rarely, becaus of the greater freedom of anastomosis. Sometimes the smaller vessels are affected most, so that the superficial parts, skin, or mucous membrane, as the case may be, are channeled in all directions by a *reticular* network, which may even raise up the epidermis in the form of minute vesicles; sometimes the larger ones, *tubular lymphangeiectasis*. The same thing occurs in connection with the veins, but in neither is the reason for the difference obvious. After a time the condition known as *solid œdema* follows: the part becomes hard and brawny; the skin and the subcutaneous tissue are thickened and indurated; an enormous growth of lowly organized connective tissue takes place throughout the limb; the muscles waste; the veins are compressed, making matters worse; the part becomes so heavy and stiff that the patient can hardly use it; and at length it develops into a state practically identical with *elephantiasis*. At first the outline is smooth, uniform, and rounded; but after a time local inflammation occurs from some trivial cause, owing to the poor nutrition of the part; and then it becomes irregular and nodulated all over. Finally, in some cases, rupture of the lymphatics takes place; a thin clear fluid, coagulating more or less perfectly, continues to drain away (*lymphorrhœa*); the patient's health fails; and the continued moisture of the part leads to an eczematous condition of the skin, which again in its turn makes the inflammation worse.

**Causes.**—Obstruction may be due to various causes, and, according to the part of the body affected, leads to very various results.

The simplest variety is that which follows repeated attacks of erysipelas (infective capillary lymphangitis). If this recurs often, partly from the obstruction to the lymphatic vessels, partly perhaps from the chronic induration of the glands, the skin remains permanently thickened, and when the face is concerned a very serious degree of disfigurement is left.

In phlegmasia alba dolens, the form of white leg that occurs so commonly after pregnancy, it is probable that the veins are involved as well as the lymphatics, sometimes one, sometimes the other being the worst. It is rarely serious, although it often assists in the production of chronic ulcers of the leg; but I have known it, when frequently repeated, end in the most enormous nodular enlargement of the whole limb (except the foot) and lead to very serious lymphorrhœa from an opening in Scarpa's triangle.

Cancerous enlargement of the lymphatic glands in the axilla leads to the same condition in a very short space of time. The axillary vein may be ligatured and cut away with impunity; there will scarcely be even transient œdema; but when the cancerous growth involves the glands, the hand and arm enlarge to such an extent that the patient is unable to lift the limb from the bed.

The presence of parasites, especially the filaria sanguinis hominis, produces even a more striking series of symptoms. The parent worm usually resides in one of the larger central lymphatics, and from this locality discharges into the stream myriads of ova or embryos. Some of the main channels become obstructed by the inflammation that takes place around them; dilatation sets in, and in many cases rupture follows, most frequently into the bladder (probably because of the very variable degree of support the mucous membrane receives), causing chyluria, but occasionally into the cavity of the tunica vaginalis (chylous hydrocele), and sometimes even externally. The same thing has been known to occur from the pressure of tumors, and from other causes leading to obstruction of the thoracic duct.

It is probable that the disease known as *Elephantiasis Arabum* really origi-

[illegible]tes in the same way. Essentially it is a chronic hypertrophy of the skin and [illegible]e subcutaneous tissue, usually of the leg or the scrotum, causing enormous [illegible]nlargement and deformity, and resulting from repeated attacks of inflammation; [illegible]ut though thus far it resembles the worst cases of solid œdema, it differs consid[illegible]rably in other respects, especially in the peculiar form of fever and the acute [illegible]nflammatory attacks that accompany it.

The fever is of a remittent type and is known locally as elephantoid. Sometimes it is exceedingly severe, and attended with great pain; more often it is only moderate in degree and as the diseases advances tends to die out. The intervals between the attacks may be as long as a month; with each there is an outbreak of acute inflammation, the limb becoming tense and hot, the skin reddened, and even covered over with vesicles as in erysipelas. In a few days the symptoms subside, but the limb never regains its former size; and one attack follows another until the condition becomes hopeless. In the early stages the skin is but little affected; later it becomes pigmented, covered with eczema, ulcerated, scarred, roughened, and nodulated in proportion to the severity of the local inflammation.

The legs and the external genitals are the parts most often affected; the scrotum in particular, from the looseness of its natural texture and the ease with which it borrows skin from the abdomen, may be enlarged, so that it sweeps upon the ground. Very often enormous hydroceles, or dilatations of the lymphatics (varix) and lymphorrhœa are associated with it.

**Treatment.**—Much can be done to relieve the symptoms in the milder cases of lymphatic obstruction, even when the cause is beyond control; rest in an elevated position, massage, bandaging, support when the limb hangs down, and, according to some, the constant current (the positive pole always nearest the sound parts) often effect material improvement in a very short space of time. Cancerous obstruction, however, of the axilla, and obstructions to the abdominal lymphatics and lacteals rarely admit even of relief.

Elephantiasis in its milder forms should be treated in the same way. Rest, pressure, and elevation succeed best during the acute stage, combined with suitable constitutional measures. Afterward either support and pressure must be used, Martin's elastic bandage being of especial service, or, if the mass is such as to disable the patient, it must be removed, by amputation in the case of the leg (it rarely extends far up the thigh) or incision if it is the scrotum. In either case, the part should be well bandaged and elevated first, in order to reduce the amount of blood it contains as much as possible, and careful examination made so that no hernia is overlooked.

An attempt should always be made to dissect out the penis from the enormously hypertrophied prepuce; and sometimes at least the testes can be preserved, their position being easily ascertained by the amount of the hydrocele fluid that surrounds them.

Ligature of the main artery of the limb has been practiced with temporary alleviation; possibly compression deserves a further trial.

# CHAPTER IV.

## *INJURIES AND DISEASES OF NERVES.*

## INJURIES.

Nerves may be divided, wholly or in part; torn across, or torn out of the spinal cord; bruised from external violence; or compressed against some resisting structure. The immediate effect is an interference with the conducting power of greater or less extent and duration, according to the kind of injury sustained.

### I. Wounds of Nerves.

*Pathological Changes Following Division.*—A nerve that is cut across begins to degenerate at once. The whole of the peripheral part is involved simultaneously; the myelin runs into cylindrical masses which become granular and fatty, and at last disappear. The axis-cylinders split up into fibrils and disintegrate, so that they can scarcely be recognized at the end of a week; and the nuclei of the sheath increase in size and begin to multiply. In two or three weeks the whole of the peripheral segment is atrophied. The central end changes in a similar manner, but only for the distance of one or two nodes; above this it remains practically unaltered, it may be for years.

The subsequent course depends upon the proximity of the two ends, and upon the possibility of union taking place between them.

(*a*) *When they are in Apposition and the Wound Heals by the First Intention.*—Union takes place by what is known as nerve-callus, vascular granulation-tissue developed from the nuclei of the sheath and perineurium as well as from the ordinary sources. In animals newly-formed axis-cylinders grow from these nuclei, connecting one end with the other, within three or four days. In man this has not been proved; but in all probability the same mode of union does occur, though rather more slowly, as occasionally, when placed under very favorable conditions, the conducting power of a divided nerve returns within a few days. Such a result, however, is exceptional; immediate suture, even when apposition is accurate, usually requires weeks.

(*b*) *When the Ends are Not in Apposition.*—The changes that follow are more complex and depend largely upon the distance between.

Bowlby has described a process of spontaneous regeneration as taking place in the distal segment six or seven months after section. The nuclei of the sheath increase in number, become spindle-shaped, range themselves in rows in the spaces of the perineurium, and gradually transform themselves into fibrils, round which a myelin sheath develops. How far this takes place in all cases, even whether it occurs in all, is uncertain. That it must materially assist the restoration of function in the case of secondary union there can be no question.

Repair may occur when there is an inch between the ends; and a few cases are recorded in which even greater distances than this have been bridged; but they are few and far between; and the restoration of function in most of them is very imperfect, even after a long period of time has elapsed. As a rule only a fibrous band is found, sometimes not that.

If union fails, the regeneration of the distal segment dies away again, permanent degeneration sets in, and the nerve is reduced to a small fibrous cord, the structure of which can still be recognized on cross section, owing to the peculiar nature of the perineurium. The central end may remain almost unchanged, or grow out into a rounded expansion of variable size—a nerve bulb. These are met

with chiefly in amputation-stumps, but they may occur anywhere; they consist for the most part of fibrous tissue; but in the end nearest the nerve-trunk a considerable production of new nerve-fibres takes place, although their size is small and there is only a limited amount of myelin round them.

In very old cases atrophic changes are met with in the spinal cord as well, affecting especially the intermedio-lateral column on that side, the posterior very little.

**Symptoms.**—The immediate symptoms are due to interruption in the function of the nerve, the remote ones are the pathological lesions that follow.

1. *Immediate.*—Loss of sensation over the region supplied by the nerve is definite, provided it is complete. On the other hand, persistence of sensation does not in any way negative division. Very little, scarcely anything, indeed, is known about nerve-anastomosis, either the coarse blending that can be shown by dissection, or the finer union that probably takes place in the nerve plexuses; and there are many instances in which nerves have been divided, and have even had pieces excised from them, without leaving the expected area of anæsthesia. A considerable length of the musculo-spiral, for example, has been excised without any loss of sensation corresponding to the radial. Further, in many cases the area of anæsthesia, if time is allowed to elapse, very often becomes smaller, as if collateral branches grew in all round the margin. The sensation that persists after nerve-section is sometimes almost perfect: more frequently localization is inexact, especially at first; and occasionally analgesia occurs without anæsthesia.

In any case of suspected injury the examination must be made with the greatest care. The patient should be blindfolded; the part well supported, so that there is no communicated vibration; and various kinds of stimuli used, thermic, for instance, as well as tactile. In no case may a conclusion be drawn either as to the non-division of a nerve, or its union after suture, without taking into consideration other effects as well as loss of sensation.

Loss of muscular power is equally definite, provided it continues and is followed by other signs, such as rapid wasting and disappearance of faradic excitability. Temporary paralysis may occur from shock, contusion, or compression, and be indistinguishable for two or three days. The atrophy is of the most extreme kind; the fibres lose their striation, degenerate and shrink; the nuclei multiply; the interstitial connective tissue increases, until in a very short time the whole muscular substance disappears, and nothing is left but a rigid, inextensible mass of fibrous tissue. Faradic excitability disappears very soon; there is often a distinct diminution by the third day; galvanic, on the other hand, continues longer, but rarely or never, according to Bowlby, shows the increase that usually occurs after nerve-section in animals; and the anodal closure contraction precedes or occurs as soon as the cathodal.

2. *Later Changes.*—In addition to the muscular wasting, the joints, the skin, and the connective tissues exhibit after a time very distinct alterations. The cartilages undergo fibroid degeneration, the capsule and the connective tissue round shrink and grow hard and rigid, the joints become stiff, fibrous ankylosis sets in, and osseous union has been known to follow. The skin becomes smooth and glossy. If the hand is involved the fingers assume a peculiar tapering shape, the hairs fall off, the natural wrinkles and folds disappear, and the color becomes a pinkish red. Sometimes, especially when the weather is cold, there is a constant burning pain—causalgia. Vesicular and bullous eruptions, herpes, subcuticular whitlow, and ulceration are not uncommon. In rarer cases the end of the finger is slowly eaten away, or dry gangrene sets in and involves the whole anæsthetic area. The nails are often affected; they may be short, stunted, and fibrous, or curved either across or longitudinally, so that their edges and angles bite deeply into the flesh. The connective tissue disappears, the secretion of sweat ceases, and generally (after the first few days at least) the temperature of the part falls one or two degrees. In exceptional instances it has been known to continue higher than that of the corresponding part on the opposite side of the body.

These changes are noted more or less regularly after section of any ner though, owing to the frequency with which the ulnar and median are divided the wrist and the musculo-spiral damaged in the arm, they are more commo seen in connection with the hand than in all the other parts of the body t together. Other affections, however, are occasionally met with of a more spec character.

*Perforating Ulcer of the Foot* is the most common and in some respects th most striking. It occurs chiefly in connection with locomotor ataxy and th chronic form of nerve-degeneration that is associated with it; but it is also met wi in the anæsthetic form of leprosy, after fracture of the spine with partial paralys and after degeneration of the nerves without the spinal cord being affected at a In most cases it is situated on the ball of the great toe, but it may occur on th outer side of the tread or in any part. A corn forms first; after a time the epidermis in the centre softens and breaks down, and an opening is left in the middle, which at first sight appears altogether insignificant, but if a probe is passed into it, it is usually found to extend far into the substance of the foot, and not unfrequently to involve the bone or the metatarso-phalangeal articulation. There is little or no pain, the edges of the sore are usually whitened and callous, and in many cases the skin around it is entirely anæsthetic. Not unfrequently it is present on both feet at the same time.

In the majority of cases perforating ulcer heals readily as soon as the foot is raised, protected from injury, and kept warm. Very often it breaks out again if the part is used. The nutrition of the tissues is so enfeebled that, though they can repair the effects of an injury when very favorably placed, they are unable to withstand the slightest pressure or irritation.

How far these changes are due to lesions of trophic nerves, and how far they are simply the result of malnutrition from disuse, is undetermined. In any case injury plays an important part in causing them. Sensation is lost, the immediate effect of any violence is unperceived, and fresh injury inflicted before the first has a chance of getting well. Ulceration and gangrene of the fingers, for example, which attain their climax in anæsthetic leprosy, and perforating ulcer of the foot are directly excited by injury, although they would not occur without the nutrition of the part being defective; the point at issue is whether this arises simply from disuse and anæsthesia, from the interruption of trophic nerves, or from their irritation.

There is no evidence that partial division of a nerve is followed by trophic or inflammatory disturbances more frequently than complete section. On the other hand, when it does occur, the consequences are limited to the distribution of the divided fibres, and they follow regardless of the manner in which the interruption is effected, whether by section, rupture, compression, or chronic inflammation, provided only it lasts a sufficient length of time.

## II. Subcutaneous Injuries of Nerves.

*Contusion.*—Section of a nerve is followed by the most characteristic conse quences, other injuries differ according to their severity. If, for example, th force of the blow is only slight the conductive power of the nerve is suspende for the moment, there is a certain amount of dull aching at the injured spot tingling is felt at the periphery, and often there is a subjective sense of heat, wit at times actual flushing. When the injury is more severe and the nerves are badl crushed, loss of sensation and of muscular power may be complete and followe by wasting and disappearance of the faradic excitability over the whole area sup plied. As a rule, the prognosis in these cases is good, or at least better than i section, because the physical continuity is not destroyed, and although trophi lesions may follow they usually disappear again of themselves, but occasionall they persist. Some of the worst cases occur in connection with the upper cord of the brachial plexus, one or all of them being crushed in falls upon the shoul

[illegible]s, and leaving paralysis, perhaps permanent, of a corresponding portion of the [illegible]m. When, on the other hand, the plexus is torn out from the cord (as when a [illegible]n in falling from a height catches hold of something in the hope of saving [illegible]nself) the lower cords suffer most and with them the sympathetic of the eye, [illegible]ding to narrowing of the palpebral fissure and permanent contraction of the [illegible]pil.

The diagnosis of the extent of the damage sustained in subcutaneous injuries [illegible]s very difficult. If the faradic excitability of the muscles persist, the hurt is [illegible]robably slight. If it rapidly disappears and this is followed by wasting and the [illegible]eaction of degeneration, there is no doubt that the physiological continuity of [illegible]some of the nerve-fibres is interrupted, and if the whole of the muscles supplied [illegible]by the trunk are affected in this way it is highly probable that the nerve itself is torn across.

*Compression.*—The same symptoms are caused by gradual compression, whether this is due to the growth of a tumor (a cervical exostosis, for instance, pressing on the brachial plexus), the enlargement of an aneurysm, the growth of callus, the contraction of a cicatrix, or some external agent. Paralysis of the musculo-spiral is not uncommonly caused by a person going to sleep with the arm hanging over the back of a chair, the nerve in this particular position being caught, almost unprotected, between the wood and the bone. When the cause is slight and only temporary, there is merely tingling or pricking, followed by numbness and a sense of warmth, with some loss of power over the movements of the part; in more severe cases, the anæsthesia and paralysis are complete, but the prognosis, if the cause can be removed, is usually favorable. Crutch paralysis is perhaps the most common form, sensation being less affected than movement, but both varying very greatly in distribution. Whether the curious instances of paralysis of one or more of the nerves of the arm (sometimes of the whole brachial plexus) occurring during sleep are to be accounted for in this way, or, as Duchenne tried to prove, by cold draughts at night, is doubtful. The absence of any evidence of neuritis renders the latter explanation very difficult to understand.

*Stretching.*—The effect of violent strain upon a healthy nerve is closely similar, the pathological lesion probably being of the same character—interruption of the medullary sheaths, with extensive disturbance of the axis-cylinders (rupture only in very severe cases), minute hemorrhages, and, subsequently, congestion. The worst instances occur in connection with dislocations, the injury being caused sometimes by the pressure of the displaced bone, sometimes by the tension to which the nerves are subjected at the time of the accident or in subsequent attempts at reduction.

**Treatment.**—(*a*) When a nerve is divided in an open wound, the two ends should be found, brought together as accurately as possible, and sutured with chromic gut or fine kangaroo tendon. There is no objection to passing the suture through the nerve itself; indeed, in the case of small ones, it is the only way in which it can be effected; but the needle used should be flattened from side to side, so as to inflict the minimum of injury. In the case of large ones the sheath should be sutured as well. The rest of the wound is treated according to the condition it presents; the limb placed upon a splint to prevent tension upon the sutures, and every endeavor made to procure union by the first intention.

As already mentioned, perfect recovery may take place within a fortnight, so that no difference is perceptible to the patient or to others. This, however, is exceptional. In the majority, trophic lesions begin to show themselves, and then, slowly, after some months, disappear again; sensation returning before movement and voluntary power before electric excitability. No case should be considered a failure until at least a year has elapsed; sometimes no improvement can be detected for months, then it sets in and progresses rapidly; sometimes it is steady and gradual from day to day. Bowlby explains the differences, in part at least, by the independent regeneration of the distal segment, which is no doubt has-

tened very considerably as soon as connecting axis-cylinders develop in the intervening splice.

The ultimate prognosis is fairly good, but complete failure occurs in a certain number of cases, partial failure in many more, delicacy of touch and accuracy of movement being impaired; and in all, or nearly all, the sense of localization requires re-educating. The presence of suppuration distinctly diminishes the chance; in one or two instances, indications of commencing recovery have suddenly disappeared again, probably owing to the onset of inflammation checking repair.

(*b*) When the injury is a subcutaneous one from the commencement, or the wound (if there was one) has healed, every endeavor must be made to assist the natural process of repair. Rest, pressure, bandages, splints, cold, position, and elevation may all, or some of them, be required, according to the nature of the injury. Everything else must wait until time has been given for the parts to be restored to their natural condition.

The only exception is in those cases in which the compression is progressive, due to some internal cause; for these, naturally, something further is required; callus, for example, if it does not soon become absorbed, must be cut away and the nerve dissected out; a cicatrix in the soft tissues must be treated according to circumstances; an exostosis removed, or perhaps the nerve displaced a little to one side to avoid the offending body.

If the faradic excitability of the muscles persists, recovery takes place rapidly; if it disappears and is succeeded by wasting and the reaction of degeneration (as always occurs after section) the prognosis should be more guarded, and means must be taken to maintain the nutrition of the part as soon as the fear of inflammation is past. Warmth, friction, massage, stimulating liniments, galvanism, everything, in short, that can improve circulation and nutrition is beneficial; and, especially if there is any anæsthesia, great care must be taken to protect it from injury. The galvanic excitability increases in animals for some time after the faradic is lost; but by the end of four months the muscles refuse to react to either. In man it is doubtful whether the increase takes place, but the galvanic excitability, at any rate, lasts very much longer than the faradic, and for this reason galvanism is preferred, as treatment, to faradism. The sittings should not be too long or too frequently repeated; every other day for a quarter of an hour is usually enough, the time, of course, being chiefly determined by the extent of the paralysis and the number of muscles concerned. Massage should be applied afterward, and a weak ascending current used at the end to diminish the sense of fatigue. The skin is thoroughly well soaked with salt and water first; and care must be taken not to irritate an insensitive part by using a current that is too strong. An occasional interruption now and then, reversing the direction, is said to be very beneficial.

Increased sensitiveness of skin is the first sign of recovery. If this is noted, the treatment is continued in the same way: in some cases improvement is very rapid; the muscles soon regain their shape, although their strength and size and the accuracy of their movements may be defective for a long period; in others it is much more slow. After section, voluntary power returns before electric excitability, but this is not invariable in subcutaneous injuries.

How long this should be continued, supposing there is no improvement, varies with each case. In a child, for example, repair, if it is going to take place, begins earlier than in an adult: probably six months may be taken as the limit. If, at the end of this time, there is no sign of improvement, it does not follow that there never will be any: but it is almost certain that it never will be very perfect, and that while secondary suture does not add any material risk, it offers the possibility of considerable benefit. If a neuroma has developed upon the central end, repair is hardly possible.

*Secondary Suture.*—This may be performed at any time after failure of primary union. If an attempt was made to secure this at the time of the injury, it is advisable to wait for some months; conductivity does not return equally soon

all cases. If no attempt was made, the sooner secondary suture is performed e better. According to Bowlby, so long as the case is of less than a year's ation, the amount of time does not influence materially either the rapidity h which union takes place or its perfection. After two years, however, perfect covery is very doubtful, although a certain degree of improvement has been ed even at the end of twelve. As in primary suture, the period at which sen- ion and motion return is exceedingly variable. The former has been known appear again within twenty-four hours, or two or three days (and sometimes in ese cases, probably owing to changes taking place in the wound, it fails later); ile in other instances it has been months and even a year before there was ecided improvement. The latter, as might be expected from the change the scles have undergone, and the necessity for them almost to grow again, is nger still, months and even years not being uncommon. No case, therefore, ould be given up as a failure until at least two years have elapsed.

The method of performing the operation is very simple, although in carrying it out great difficulties may be encountered. Esmarch's bandage should be applied, so that everything may be seen without confusion. An incision is made over the seat of division, frequently traversing a scar, and the ends of the nerves sought. The upper one, especially if it is bulbous, usually presents but little difficulty; the lower, on the other hand, may be so shrunken, fibrous, and matted to the structures around that it can scarcely be recognized.

The bulb on the upper one should be cut away and no more; the less of the lower one that is sacrificed the better; it may appear hopelessly atrophied, but it is not in a more favorable condition further away.

If, after they are freed from adhesions, the ends can be brought together without much traction, they should be sutured with chromic gut, as already mentioned. In many instances, however, there is a great gap between, and sometimes this is the case in primary operations when a considerable portion of the nerve has been lost or is too much bruised to live.

An additional inch or more may be obtained by stretching the ends, having first removed the bandage. If this fails there are various methods which have been recommended and some of which have been tried successfully.

1. Nerve-splicing is said to have succeeded (Després), the distal end of the divided median having been implanted between the separated fibres of the uninjured ulnar.

2. Flaps have been used. An incision partly through the trunk of the nerve is made some little distance from the end, and a flap of nerve-tissue reflected downward from it, leaving it attached at its base, so as to bridge across the gap. This, too, is said to have been of use, sensation returning in four weeks and complete recovery in one year.

3. In a dog, the sciatic nerve was resected, the two ends sutured at some distance, and inclosed in one of Neuber's decalcified drainage-tubes. Union followed, but such a proceeding would be hardly likely to succeed in man.

4. The humerus has been resected in order to bring the ends together.

5. Grafts from animals have been used, portions of freshly excised nerves being imbedded in the gap and fixed. In one case in which a rabbit's nerve was employed to replace part of the ulnar and median, sensation returned in four weeks and movement in nine, although the gap was more than two and a half inches in width (Tilleman's). In another case, in which the sciatic nerve of a dog was used, the result was doubtful.

6. Finally, Mayo Robson, in a girl fourteen years of age, removed two inches and a quarter of the median nerve for a neuroma, and two days later transplanted into the gap a portion of the posterior tibial from a recently amputated leg. Sensation began to return within thirty-six hours, and within four months was almost complete, although some of the muscles were still much wasted.

There is no doubt that any of these measures would be much more likely to succeed in a case of primary suture than where the distal end has been already

4. *Tetanus.*—Whether this disease is ever produced by peripheral irritation pen to question. It certainly is one of the rarest of all rare complications, if number of accidents and operations in which nerves are injured is taken into sideration. On the other hand, its distinctly epidemic occurrence, the period incubation, and the general course of its symptoms strongly favor its microbic gin, even if no weight is attached to the somewhat contradictory results of eriment. Probably the only valid reason for including it here is the occasional urrence of tetanic contractions after subcutaneous injuries (simple fracture, for mple) in which nerves had been strained or stretched.

It must be remembered that tetanus, the disease, is a very different thing from smodic muscular contraction, even though this is tetanic in character.

## DISEASES OF NERVES.

### NEURITIS.

Inflammation of the peripheral nerves may be acute or chronic; in either e the active changes are limited to the connective tissue; the medulla and the s-cylinders are only involved secondarily.

*Acute Neuritis.*—The whole nerve is swollen, softened, and intensely con-ted. The sheath and the septa of cellular tissue are thickened and infiltrated h lymph, and in severe cases the section is strained with minute extravasations; suppuration is rare. The myelin breaks up and disappears, the axis-cylinders ome indistinct, the nuclei of the sheath are said to increase in number, and in worst cases the whole appearance of a nerve is lost. Such extensive changes his, however, are very rarely met with.

*Chronic Neuritis.*—In this there is an increase of all the connective-tissue ments of the part. The sheath is thickened and adherent to the structures und; the nerve itself becomes hard and dense, shrinking after a time to less n its normal diameter, and the fibres are atrophied and in great measure dis-pear. The term chronic neuritis is, however, applied in a very general way her to a true chronic inflammation, with increased cellular exudation and ganization, or to a simple process of degeneration, in which the nerve fibres ophy in much the same manner as after section. In many of the forms of -called neuritis there is no evidence, past or present, of inflammation of any nd.

**Causes.**—Inflammation occasionally follows injury, even when the skin is broken: why, it is difficult to understand. Acute or chronic inflammation of e cellular tissue in or round a nerve can, of course, be caused by the presence of reign bodies or of micro-organisms; but the result is very rarely proportionate the cause, either as regards severity or persistence of the symptoms, and the rst cases not uncommonly follow such accidents as sprains. There must be me other factor as well, very likely a personal one.

The influence of cold is variously estimated. The sciatic and facial nerves e the most often affected, the latter, it is said, being compressed by effusion in e bony canal, so that facial paralysis results; but, according to Duchenne, neuritis much more common than is usually believed; certainly many cases of paralysis, pecially of the musculo-spiral, commence during sleep, whether they are caused cold or pressure.

Neuritis is not uncommon in gouty and rheumatic subjects as a result of posure to cold and wet, especially after great fatigue. The fibrous sheath is led with inflammatory exudation which compresses the nerve filaments and in l probability the nervi nervorum as well, judging from the intense local pain d tenderness.

In syphilis degeneration of peripheral nerves is not uncommon, and, of gummata occasionally develop in connection with them. In anæsthetic chronic form of inflammation is the essential lesion. The abuse of

alcohol is stated to be the main element in the production of what is known progressive multiple neuritis. Degeneration akin to inflammation, if not dependent upon it, occurs sometimes in locomotor ataxy, Pott's disease, chronic myel etc. But even when full allowance is made for all of these there is a very l residue for which no explanation is forthcoming. Some of the cases are distinc inflammatory; others (those, for instance, associated with herpes zoster sloughing bed-sores) only exhibit degenerative changes; there is no evidenc true neuritis; but the changes are so much more marked and so much more ra than those that follow simple section that it does not appear advisable to separ them.

**Symptoms.**—1. *Constitutional.*—These depend upon the severity and extent of the inflammation; rigors, high fever, and delirium are present in the worst cases, but these are very rare. In chronic ones constitutional signs may be altogether wanting.

2. *Local.*—These vary with the character and connections of the nerve, whether it is motor or sensory. In acute inflammation the trunk is enlarged, excessively tender, and the skin over it is reddened and hyperæsthetic. There is the most intense pain, radiating over the whole area of distribution, sometimes of a burning character (causalgia), sometimes dull and aching, with numbing, pricking, and tingling sensations. Muscular twitching and fibrillar contraction may be present in the earlier stages, but tonic spasm is more common, and in a little while this gives way to loss of power, with rapid wasting and diminished faradic excitability. Paralysis, more or less complete, trophic changes of the most varied character, and anæsthesia are the final stages, the pain frequently continuing the whole time; but naturally the extent to which these occur differs in every case.

Traumatic neuritis is always local at first, but in many instances it spreads upward along the nerve trunks until it meets other branches, involves these as well, and may finally implicate the whole of a limb. Then at length it subsides or becomes chronic, leaving the muscles wasted, the joints stiffened, the nerves thickened and tender on pressure, and the general health, both of mind and body, impaired from prolonged suffering.

Other forms of neuritis are seldom very acute, although many of them, especially the rheumatic, are often severe; pain, tenderness, swelling along the course of the nerves, wasting of the muscles, and diminished faradic excitability are rarely absent; sometimes they are marked as in the traumatic variety; sometimes, on the other hand, as when the facial nerve is paralyzed from cold, the effect is comparatively slight, consisting merely of temporary loss of power without any very perceptible alteration in the electric reaction.

A peculiar form of multiple neuritis is described as occurring in connection with alcohol and syphilis, although it is doubtful whether these are to be regarded as the sole cause. In some cases it is stated to have originated from cold. The hands and feet are first involved, the extensor muscles on the front of the leg suffering so often that, according to Buzzard, this of itself is diagnostic. The pain is intense; numbness with formication and a sense of fearful burning are nearly always present. The nerves are swollen and tender; the skin red and glazed other trophic lesions follow and rapidly spread up the limb. Muscular power is lost almost from the beginning; reflex phenomena disappear; the reaction of degeneration sets in; wasting is extreme, the muscles remaining flaccid, without becoming fibroid; and the movements resemble those of locomotor ataxy. In some cases there is a considerable degree of fever as well, and the general health usually fails rapidly. The course of the disease is very variable; in a few cases it has continued to spread, commencing at the extremities and rapidly advancing until the spinal cord became involved; in some it has remained stationary for a long period often at the level of the hands or feet, and then disappeared again, recovery taking place often under anti-syphilitic treatment; while in others again it has steadily progressed from bad to worse, until the patient from exhaustion or was carried

by some intercurrent disorder. Some of these cases are difficult to distinguish from tabes dorsalis; the gait is ataxic; there are girdle pains, and not unfrequently lightning ones as well; but as a rule in spinal ataxy the electric reaction of the muscles continues normal.

**Treatment.**—Constitutional measures are most important. In the vast majority of instances, even if the inflammation is excited by cold or injury, its persistence and severity are due to some other cause, whether gout, rheumatism, syphilis, malaria, chronic alcoholism, or debility, and by itself local treatment is not likely to succeed.

In acute neuritis the first thing is to relieve the almost intolerable pain; warmth, belladonna, fomentations, injections of morphia, Indian hemp, and other anodynes are the most useful. Afterward, when the first severity of the attack is past, narcotics, and opium in particular, should be employed as little as possible. Counter-irritants, leeches, blisters, iodine, and even acupuncture are of decided benefit; warm and Turkish baths frequently give great relief, particularly before going to bed; the constant current interrupted occasionally and preferably weak, but long continued, is often most successful, and in the later stages, when the extreme tenderness has subsided in some measure, massage does more good than anything else, in all probability by causing absorption of the inflammatory exudation and preventing the formation of adhesions and dense cicatricial tissues.

Quinine and salicylic acid are sometimes very useful. Stretching the nerve itself, paralyzing the nervi nervorum and freeing the sheath all round, has proved of great benefit, even in such diseases as multiple neuritis and anæsthetic leprosy, and in the worst cases is almost certain to give temporary relief.

## NEURALGIA.

By neuralgia in the general sense of the term is meant an acute paroxysmal pain in the course of a nerve. In many cases it is really a symptom of neuritis, or of disease of the brain or spinal cord, and the treatment must be guided by the cause. Sometimes, however, it does occur with great severity without there being any perceptible change in the nerve or the centre from which it springs.

Neuralgia of this type is nearly always due to some constitutional disorder, although it may be started by a local cause. Neuralgia of the testes, for example, arising from irritation of the kidney, or of the face from the presence of a carious tooth, is seldom severe except in those who are predisposed to it by a constitutional affection, whether it is mental or physical, hereditary or acquired. It is especially common among members of what may be called, for want of a better term, neurotic families. Anæmia, dyspepsia, over-lactation, mental worry or overwork, malaria, gout, debilitating influences of all kinds, may induce it; but the worst form of all, that which is known as epileptiform neuralgia, or when it involves the fifth nerve, as tic, has so far eluded every attempt at finding a reason. It may occur in both sexes, in the young as well as the old, the robust as well as the weakly, and it may so completely destroy strength and health, both of mind and body, as to drive the patient to commit suicide.

This peculiar variety of neuralgia is usually met with in the face, affecting one of the branches of the fifth pair, or in severe cases all of them. The pain is paroxysmal, of the most intense description, coming on instantaneously from the slightest cause—a touch, a breath of cold air, an attempt at mastication, or even from no cause at all; it may last a few seconds or some minutes; and it may come on at frequent intervals, or not for days and even weeks. Whenever it occurs the sufferer describes it as the most intolerable agony, usually comparing it to something burning. There may be convulsive spasm with it (*tic convulsif*) or not; in many cases there is profuse lachrymation, in others the mucous membrane of the nose and mouth is hot and dry, occasionally the whole side of the face flushes, and in many instances the hair is affected too. Usually in its earlier stages it is traceable to some tooth as its starting-point, but in the true epileptiform variety it is not

uncommon to find that the patient has had every tooth on that side of the h removed without experiencing even a temporary cessation.

Closely akin to this is a variety of neuralgia that is occasionally met with amputations, different altogether from that which is due to the nerve-ends hav become bulbous or entangled in the scar. It does not begin until the wound sound. The whole of the stump is the seat of a fearful burning pain, though to touch it is intensely cold. The skin is red, glazed, and congested, the co returning very slowly after pressure. The muscles of the joint above, and so times of the whole limb, are in a state of constant spasmodic twitching, and pain radiates not only through the amputated part but over the whole of the lim This (though, like tic, it may have commenced as a local affection from a lo source of irritation) when once established is only too liable to become permane in the same way that local epilepsy sometimes does, either from constant repetitio only, or from a peculiar unstable condition of the central nervous system; and have known it return after four successive amputations, and even after the nerve had been stretched on the face of the stump as far as they could be without being torn out. No single one appeared to be involved, the disease, whether central o not, was general.

**Treatment.**—The ordinary form of neuralgia is only a symptom of an affec tion either of the nerve itself (neuritis) or of another part of the body, and the treatment essentially consists in finding the cause, whether local or constitutional. If nothing is discovered, all that can be done is to relieve the symptoms by large doses of quinine, salicylic acid, croton-chloral hydrate, or tincture of gelseminum internally, and anodynes—belladonna, veratria, aconite or menthol—locally. Naturally, as the constitutional condition that underlies the case may be of the most different description, the line of treatment required for one patient is often diametrically opposed to that advisable for another. Purgatives, colchicum, iodide of potash, and alkalies may suit one; while complete change of air, often to the seaside, rest, tonics, iron, quinine, arsenic, strychnia, or phosphorus may be required for another. Very great care is essential in advising stimulants or morphia.

Epileptiform neuralgia is rarely benefited except by operation, and even then in too many instances only temporarily. As a rule, by the time the neuralgia has assumed this type all the teeth on that side of the head have been extracted in the hope of obtaining relief. Sometimes this is successful, but in the worst form either the patient is entirely unable to state from what particular spot the neuralgia starts, or else, if there clearly is one offending tooth, no sooner is it removed than the pain transfers itself to another. Careful examination, however, should never be omitted; there is more than one case on record in which excision of part of the gum or of the alveolar border succeeded after all.

Quinine seems to have no control over it; anodynes soon lose their effect; morphia, if persisted in, only makes the condition of the patient worse. Galvanism is sometimes beneficial. If this fails, nerve-stretching may be tried, and as a final effort the whole nerve may be removed with its branches as far as possible, up to its exit from the cranium. The trunk most commonly affected is the superior maxillary, and there is a sufficient number of cases in which excision o Meckel's ganglion has succeeded, to justify the operation. It is true, relief has not been permanent in all or nearly all, but in most it has lasted some months, in many one or two years, and that alone would be sufficient.

## OPERATIONS ON NERVES.

### Nerve-stretching.

The great sciatic may be stretched subcutaneously without a wound, and with almost as great success; in the case of other nerves an incision is required. If cord is a large one, one or more fingers may be placed beneath it and

tion exercised upon it, first in one direction, then in the other; as it yields a ation as of crackling or snapping is transmitted to the finger, and the length d flexibility of the part exposed are distinctly increased. Small nerves should lifted upon a rounded hook, sharp edges being avoided as much as possible.

The immediate effect is to loosen the sheath, separating it from all the struc- es around, and tear across the smaller vessels, so that its section is stained with inute ecchymoses. The myelin of the more superficial fibres is broken up into gments, many of the tubules are ruptured, and, unless the force is very extreme, e excitability is increased for a time. In a little while the part becomes more scular, some of the fibres degenerate and disappear, the nuclei of the sheath ultiply, all the interstices are filled with lymph, and the fibrous tissue becomes ollen and softened. At this stage, after its temporary increase, the excitability of the nerve diminishes, anæsthesia and loss of power follow, corresponding to the fibres affected, and the faradic excitability of the muscles is greatly depressed. Gradually this gives way in turn to regeneration; new nerve tubules are formed, the hyperæmia subsides, and at length all the functions of the part are restored.

It is especially noteworthy that the effect of nerve-stretching is not limited to the spot at which the traction is applied. It extends for long distances up and down the trunk, involves the branches that come off from it, and occasionally produces a considerable effect upon the spinal cord. It is probable that no degree of traction that can be safely exercised upon a nerve during life moves the cord to any appreciable extent; but whether this is the case or not there is no doubt that hyperæmia of the columns of Goll may follow, and that sometimes, in animals at least, sclerosis of the posterior columns makes its appearance afterward.

The effect varies with the force, and this, of course, is regulated by the size and the condition of the nerve. In some people the cords naturally stand a much higher strain than in others. The greater the length exposed the less the risk, as the force is more distributed. There is not so much fear of the nerve giving way as of its being pulled out from its spinal attachment, and great care, therefore, must be used when the part exposed is situated near the intervertebral foramina and the traction is from the centre. In any case the pull must increase uniformly without the least jerk.

To stretch the sciatic nerve subcutaneously the patient is placed under an anæsthetic, and the hip flexed while the knee is kept in rigid extension, until a sufficient effect is produced. The hamstring muscles suffer to a certain extent at the same time, the ischial tuberosity being very tender for days afterward. I have done this with temporary benefit on more than one occasion, but it does not free the sheath of the nerve from surrounding adhesions in anything like the same degree.

Neither operation is devoid of risk, especially in the case of the sciatic. Paralysis of other nerves coming up from the same region of the cord has been known to follow, and even the corresponding one on the opposite side of the body may suffer. Meningeal hemorrhage, meningitis, and myelitis have all occurred and have proved fatal, and in other cases sloughing bed-sores, cystitis, suppurative nephritis, and other trophic lesions have followed. Whether the frequency with which these occur after operations upon the sciatic is simply due to the fact that this nerve is more often affected than others, or to the exceptional amount of force that is sometimes used, as there is so little danger of tearing the trunk, is not known.

The good effect that follows the operation in so many different diseases has been accounted for in many ways. There is no doubt that old adhesions are broken across and the cord freed from constricting bands. In other cases, when the neuralgic pain is local, not referred to the periphery of the nerve, the benefit may be due to the effect upon the nervi nervorum. Something, perhaps, may be said for the increased vascularity that follows; the fibres are better supplied with blood and better nourished. But in all probability the chief good is due to the actual interruption of the fibres, both of the trunk and its branches, securing [illegible] for the centre until its normal nutrition is restored.

(except where there is some local reason, such as chronic
presence of adhesions) is usually temporary. When the ne
old symptoms return again; either the original cause still
effect upon the centre has been repeated so frequently
f time that habit has become second nature. Sometimes, h
sufficiently long, the vicious circle is broken, and the

tching has almost superseded nerve-section: it produces
nterrupting the physical continuity of the cord; it acts
ll as the trunk; a longer section of the nerve is examin
here are any, are broken across. The wound is a larger
s scarcely a serious objection.
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h occurs in anæsthetic leprosy. In many of these cases it
essful. Epileptiform neuralgia, however, is usually only
tain to return. In addition, it has been used with varying
o relieve the pain and for the ataxic symptoms, and in
l paralysis, tetanus, paralysis agitans, and spasmodic wry-
oubtful: sometimes it is said to have procured temporary
ble that the whole number, or even a large proportion, of
failed, has been published.

### Neurectomy and Nerve-evulsion.

r of these signifies merely the removal of a portion of a nerve
complete separation from the highest point that can be rea
ce of a bony canal.
ny is practiced upon the spinal accessory for uncontrollable sp
occasionally upon the nerves of the head and face for ne
is rarely tried except in the case of the second and third b
epileptiform neuralgia.
ganglion may be excised, either from the side or in front.
on the zygoma with the attachment of the masseter is separa
e latter the anterior wall of the antrum is trephined. If the
ic light or at least a reflector attached to the forehead of the
anterior operation is quite feasible, and, though permanen
lied upon to give relief for at least one or two years. A
le down to the bone over the infra-orbital foramen; a h
ed with a trephine from immediately below it, and the nerve
way the floor of the infra-orbital canal and groove until the p
. A second trephine opening is made in this, taking care
t tissues beyond, and, as a rule, Meckel's ganglion is exp
be removed with its posterior dental branches and the
nfra-orbital, thus securing complete anæsthesia of that side

or dental nerve may be exposed through the vertical ramus
bone being excised with the trephine: but in most cases it
sfactorily through the mouth, and a disfiguring scar avoided.
ed between the teeth on the opposite side, and the mouth ope
ole; the incision runs along the projecting fold of mucous mem
ne jaw to the other behind the last molar teeth, and the fin
n the internal pterygoid muscle and the ramus until the sharp
arks the orifice of the dental canal is reached. The nerve may
ard with an aneurysm needle, and separated from its connec
listance by the finger. Care must be taken not to mistake the
ligament of the lower jaw for it.

the question. In some cases a slight degree of eversion of the foot has b noticed. This peculiar accident is always attributed to rupture of the plant tendon, but I am not aware of any instance in which this lesion has been dem strated. On the other hand, I know of at least one case in which the s accident occurred twice in the same leg at a different spot within the month. Fr the symptoms, the class of person in whom it occurs, and the rapidity with whi recovery takes place, if proper measures are taken (not without), I am inclined t think that it is rather a rupture of some one of the deep-seated veins, which a so often varicose, than of that exceedingly long tendon.

**Treatment.**—The limb must be placed in the position that secures th maximum degree of relaxation, and the extravasation checked as far as possibl by cold and pressure. Firm bandaging assists in keeping the muscle from co tracting and helps to press the broken surfaces somewhat nearer. Afterward th part must be kept absolutely at rest until organization is complete. If unio takes place the nutrition will soon recover under the influence of massage and ga vanism. When the tendo-Achillis is ruptured a high-heeled shoe must be wo for two or three months afterward.

If the ends cannot be brought into fair apposition, union, of course, is impo sible. The gap grows wider and more distinct as the blood that fills it is absorbed the ends of the muscle atrophy ; and its use is entirely lost. In many cases som appliance is needed afterward—an abdominal support, for example, to prevei ventral hernia, or a thigh-belt if the adductor is ruptured.

In open wounds an attempt may be made to draw the surfaces together b deeply-buried catgut sutures passed through the whole thickness of the muscle, o through its investing layer only, but it rarely succeeds. With tendons, on th other hand, primary suture is very successful and should always be practiced Chromic gut is the best material, the sutures being passed through the thickne of the tendon, and the wound, if necessary, enlarged for the purpose. At th wrist, where deep transverse cuts are of common occurrence, this is speciall important ; but the tendo-Achillis and many others have been joined again in th way. Even secondary suture, freeing the ends from the cicatricial tissue aroun freshening them, and fastening them together, is very often successful ; but t greatest care must be taken to secure union by the first intention, and the lim must be held rigidly fixed for some little time upon a splint, to avoid the smalle accidental movement.

Where the interval is too great the tendon may be split and the two en spliced, as described in speaking of nerve-suture. In one or two instances res tion of the shaft of the bone has been performed to reduce the size of the ga and transplantation of a muscle from a dog into the biceps is said to ha succeeded.

Rupture of the plantaris tendon requires an entirely different method. T limb must be raised for a few minutes in order that the œdema may subside ; a then carefully strapped and bandaged from the foot upward. As soon as this accomplished the patient is to walk with his heel well down upon the ground ; t sooner it is done, the more speedy is recovery ; prolonged rest always leave most serious degree of stiffness, probably from the organization of the extravasat blood tying together all the planes of cellular tissue between the muscles. T bandage should be renewed as soon as it becomes loose, and should be kept on eight or ten days. Any stiffness that is left disappears rapidly under massage a hot douching. Reunion of the tendon, if it is really ruptured, does not appear be material.

### Dislocations.

The peronei tendons are occasionally displaced from behind the exter malleolus in severe sprains of the ankle, in spite of the tough fibrous sheath t binds them down. Reduction is easy, but often it is almost impossible to ret

them in position. The foot should be carefully bandaged, with firm pressure behind the bony projection, and passive motion commenced at the end of the first week at the latest. It often happens, however, in spite of every care, that repair is not perfected, and that some trivial slip, even months later, tears the old wound open again.

The extensor tendons on the back of the wrist suffer in the same way, but rarely give rise to more than temporary inconvenience. There is a moment's pain; the tendon slips back, and, beyond a certain feeling of soreness and weakness, the use of the hand does not suffer.

The long tendon of the biceps may be displaced from its groove, although no doubt many of the cases in which this accident has been diagnosed are really the result of rheumatoid arthritis. There is a sudden twist with a sensation of sickening pain, and the use of the arm is restricted in certain directions; it cannot be raised above the level of the shoulder, and the head of the bone is too prominent in front; then, suddenly, after a little manipulation, a snap is felt, and full power is regained almost immediately. In one case under my care this occurred on several occasions, the patient being able to throw the head of the bone out of gear, as it were, almost at will; and although the diagnosis was not verified, it is difficult to understand what other kind of lesion could have given rise to so peculiar and constant a train of symptoms.

Similar accidents have been recorded in connection with other tendons. Thus the tibialis posticus may be displaced from behind the internal malleolus in the same way as the peronei on the outer side of the foot; and the sartorius may be forcibly wrenched from its surroundings at the knee-joint (especially when the knee is flexed); but these are all rare. Displacement of the tendon of the quadriceps in cases of genu valgum is regarded rather as a dislocation of the patella.

The slender muscular slips that lie packed side by side in the neck and in the loins are sometimes displaced; but it is doubtful whether this should be called a dislocation. It usually occurs in some sudden awkward action, when, for example, the head is twisted round to look upward. There is a sensation of something giving way, or of a snap, with acute pain; and the head is either fixed, or is very slowly and painfully brought into a straight position again. In some instances this is caused by the momentary locking of the articular processes, or strain of the capsular ligaments; but occasionally a distinct, elongated, and very tender swelling has been noted, and complete relief has followed rapid manipulation, the muscle being pressed back into position while the patient endeavors by some sudden action to make it contract. Many of these cases, however, are probably due to tearing of the membranous fascia enclosing the muscle and partial hernia, or to rupture and extravasation in its substance. Either of these hypotheses would explain the facts equally well.

## ATROPHY.

Muscular atrophy may be due to the supply of blood being insufficient; to affections of the nerves or nerve centres; or to both together.

Deficient supply of blood, such as arises from disuse, the pressure of an elastic stocking, or the ligature of the main artery of a limb, causes simple wasting, with or without fatty degeneration. The electric reaction is not affected; the size and strength of the muscles diminish; they lose tone and feel soft and flabby to the touch, but it requires nothing more than increased vigor of circulation to restore them. As soon as the cause is removed, they begin to improve at once with massage and galvanism.

Atrophy due to affections of the nervous system is more serious. If the nerves are divided, faradic excitability diminishes from the first, and may disappear altogether in the course of a few days. The same thing occurs with the slowly interrupted current; but, for a little while (at any rate in animals), the irritability

appears to be increased, and a peculiarly slow and continuous contraction is ca by stimulation that is not strong enough to make any impression upon a heal structure. This may last for a week or two, but rarely for much longer; and the end of three or four months, if the separation is complete, the muscles a insensitive to stimuli of all kinds. The atrophy that occurs in connection w neuritis is almost as rapid; but the worst examples of all are seen in infant paralysis, and progressive muscular atrophy, when the centres in the anter cornua of the spinal cord are destroyed. In these diseases the correspondi muscular fibres may waste so completely that no trace of them can be found.

Muscular atrophy following lesions of the motor area of the brain is no accompanied by the reaction of degeneration; the fibres simply waste away from want of use. Rigidity, tremors, and contraction, however, follow if secondary descending sclerosis sets in and involves the motor tracts in the spinal cord.

### Functional Disorders.

Loss of power, with or without spasmodic contraction, is sometimes met with in muscles that are constantly overworked; and, as no definite lesion is known to exist, it is usually described as functional impotence and functional spasm. It may affect a single muscle by itself (the peroneus longus for example), so that it either remains powerless or in a state of rigid contraction, instead of shortening and relaxing in harmony with the rest; or more frequently it involves a group associated together for some particular action, and only when that action is being carried out; for all other purposes they are as strong as they were before.

The most common example is known as *writer's cramp*, the muscles of the hand being affected only when an attempt is made to grasp and direct a pen; but it is frequently met with in other occupations (so that it is sometimes known as a professional neurosis), especially those in which finely adjusted movements are kept up without intermission for a great length of time. At first there is little more than a sense of fatigue; the pen is grasped more tightly, or is held in some unusual way; then involuntary contractions set in; at the beginning they are only of momentary duration; soon they become more persistent and exaggerated; the more attention that is paid to them, and the greater the effort, the worse they grow; the muscles of the forearm become involved as well as those of the hand; even those of the head and neck may suffer; then they spread to the opposite side of the body; and finally, the least attempt at placing the hand in position is sufficient to throw it into a state of the most violent and painful agitation.

The electric excitability of the muscles is usually slightly depressed; the nerves, especially the median, are tender on pressure; neuralgic pains are very frequent, at first only when the one particular action is attempted, but later more constantly; and partly from this, partly from the mental distress, the general health fails and the nutrition of the muscles becomes still more impaired; but there is no evidence of neuritis or of any gross pathological lesion. It may occur even in those who are strong and healthy; but it is distinctly more frequent in members of neurotic families; and in a few cases it can be traced, in part at least, to slight hemiplegic attacks occurring at an earlier period of life; recovery is perfect for all ordinary actions, only unusually delicate combinations such as these are carried out at a disadvantage, and fail in perfection sooner than they otherwise would. The style of writing is probably of some importance. Those who rely upon their fingers only, who do not use the wrist or forearm, appear especially subject to it. Short-hand writers, whose style is necessarily very free, are seldom affected.

It is probable, as Vivian Poore suggests, that these disorders (or at least writer's cramp, which may be taken as the type of the rest) are due to neuro-muscular fatigue, the tenderness along the course of the nerves, the tremors, and the diminished excitability all being susceptible of the same explanation. Certainly the

most successful remedies are those which tend to improve muscular nutrition. Massage, combined with passive motion and suitably arranged exercises, has met with the most conspicuous success, cases of many years' duration having begun to improve almost at once, and having been at length completely cured, so that full power of writing was regained. At the same time tonics, galvanism, and local injection of strychnia are of very great assistance. Rest alone effects but slight alleviation, and that only of a temporary character.

FIG. 81.—Nussbaum's Instrument for Writer's Cramp.

In early cases the appliance invented by Nussbaum may be used with benefit. It is framed to exercise the extensors and abductors of the fingers, so that they may be better able to resist and overcome the spastic contraction of the flexors and adductors (Fig. 81).

## CONTRACTURE OR PERMANENT SHORTENING.

This is distinguished from ordinary muscular rigidity (such as occurs in the early stages of inflammation of a joint and in hysteria), by its not relaxing under an anæsthetic. The change is in the sheath and the connective tissue of the muscle; the fibres atrophy, the cross section is very much diminished in size, and in some of the more extreme cases scarcely any trace of true muscle substance is left.

It is produced in various ways. A mild form of it may be caused by prolonged rest in one position, as in the case of the gastrocnemius, when the patient is confined to bed; the worst cases are usually the result of chronic inflammation of the muscle itself, descending neuritis, or persistent irritation along some portion of the motor tract. Hence its frequency in descending sclerosis following lesions of the cortex.

Slight cases, provided the cause is not a persistent one, can be cured by massage and passive motion; tenotomy, however, is often necessary in old joint disease, before the parts can be restored to their natural position. Section should always be subcutaneous, and performed at the spot at which the muscle (or preferably its tendon) is most superficial and farthest away from important structures.

## MYOSITIS.

Subacute inflammation of muscles usually occurs in connection with gout, rheumatism, and exposure to cold and wet, or it follows prolonged overwork, or a sudden strain rupturing some of the fibres. The pain is often severe, especially at night, and when an attempt is made to move the part; and this, combined with stiffness, is the most conspicuous feature. Fever, swelling, and local pyrexia are seldom present. Inflammation due to other causes is more rare, although it sometimes extends into the muscles from the surrounding structures, and occasionally arises from direct infection through a wound or through the blood.

In chronic inflammation the exudation becomes organized and contracts while the muscular substance itself wastes and degenerates. In many cases this ends in a condition of rigid contracture, requiring prolonged massage and even tenotomy before use of the part is regained; and ossification is not uncommon, spreading from the insertions of the muscles into the tendons and along the fibrous septa, until the bones are covered with irregular osteophytes.

*Suppurative* myositis may either occur as a local affection (an abscess forming in the substance of the muscle, from injury, or the impaction of a foreign body),

or as part of a general infective disorder. Diffuse suppurative myositis, for ex
ple, sometimes breaks out under
same conditions as diffuse inflam
tion of the cellular tissue, or dif
suppurative periostitis, although i
much more rare; the pyogenic
ganisms gain access to the p
through a wound, or when the sk
is unbroken through one of the m
cous surfaces, and owing to th
being accidentally favored in so
way (by extreme fatigue, for instan
give rise to wide-spreading suppu
tion.

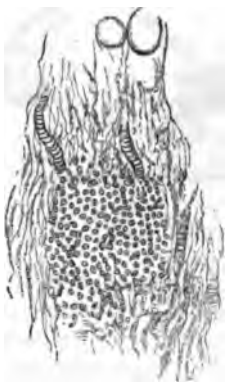

FIG. 82.—Showing the Early or Cellular Stage.

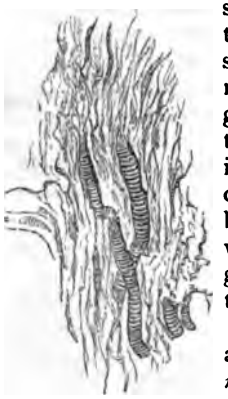

FIG. 83.—The Late or Fibrous Stage.

From a case of sterno-mastoid induration in an infant.

In addition to this, a few ca
are recorded of an *acute progress*
*myositis*, involving all the volunt
muscles of the body, and gener
proving fatal from asphyxia or pn
monia. It appears to resemble tri
inosis in many of its features, and
all probability is parasitic, although as yet no actual evidence is at hand. Infla
matory swelling of the muscles, with the most intense pain, so that the patient
barely move; an urticarial or papular eruption upon the skin, followed by œde
and rapidly increasing weakness, have been noted in all; while in some there
cramp, or a tonic contraction of the muscles, with insomnia and profuse sweati
The diaphragm, heart, and bladder appear to escape.

In all the cases examined evidence of acute inflammation has been fou
sometimes parenchymatous, the fibres being pale, rigid, friable, and infiltra
with serum; sometimes, on the other hand, interstitial, with hemorrhages scatte
everywhere among the fibres.

*Gummata* are not uncommon, especially in the tongue and the ster
mastoid. In the latter muscle a peculiar firm and hard nodule, which is certai
not always due to syphilis (Figs. 82 and 83), is sometimes noted shortly after bi
In most instances it appears to be traumatic.

Leprosy, tuberculosis, and other similar diseases give rise at times to spe
deposits among muscular fibres, as in other tissues.

A very peculiar form of inflammation is occasionally met with (*myositis os
cans*), in which large plates of bone are developed, chiefly in the dorsal reg
but also all over the body, in the substance of the muscles, so that the bo
become united together by osseous sheets of the most fanciful shapes. Notl
is known as to its pathology.

## TENO-SYNOVITIS.

The synovial sheaths of tendons resemble the deeper bursæ and the lin
membranes of joints in structure and pathology. Inflammation may be caused
any continued irritant, organized or unorganized. The simplest form is that
to mechanical injury, such as tension or overwork; others, more severe, are
result of specific ailments, gout and rheumatism, for example, or of infection
in tubercle and syphilis; suppuration never occurs without the presence of
genic micro-organisms, whether they come through a wound, through the bl
as in pyæmia, or directly from surrounding structures.

1. *Acute.*—Simple acute teno-synovitis is caused by strains or prolonged o
work. The course of the tendon is marked out by an ill-defined swelling, the
over it is tender and sensitive, the temperature is slightly raised, the action of
muscle is painful, and whenever the part is used or moved in any way there

peculiar soft crepitus, as of two pieces of silk gently rubbed together. The endothelial lining is detached, the surface covered with lymph, and the least movement causes friction. In more severe cases the exudation involves the loose cellular tissue around as well as the tendon sheet itself; often it is mixed with blood, and the pain, heat, and tension are more severe. The whole of the dorsum of the hand and forearm, for example, may be swollen and œdematous, and the bruising extend far above the elbow, after a fall upon the back of the hand, doubling the wrist upon itself.

The subsequent changes are the same as those that occur in other parts under similar conditions. The whole of the exudation may be absorbed without leaving after-trouble of any kind. Part of it may undergo organization (especially if there is some constitutional ailment present, keeping up a persistent though slight degree of irritation), so that the attack becomes chronic; or suppuration may follow.

2. *Chronic Tenosynovitis.*—Chronic inflammation may begin as such, or follow an acute attack, kept up either by a constitutional cause, such as gout or rheumatism, or by the presence of adhesions. This is a frequent result of over-caution and the fear of passive motion in the treatment of sprains and other injuries. The tendon-sheath, after some slight accident, is filled with lymph, which becomes organized and forms bands extending between contiguous structures, tying them together. At first these are thin and delicate, and break down at once; but if the parts are kept at rest too long, they grow firm and rigid, and then, unless they are torn right in two, or at least are stretched to such an extent that no more tension falls upon them, they become the cause of fresh attacks. Every contraction of the muscle strains them, and gives rise to pain; fresh effusion follows, and this in its turn becomes organized, and makes them stronger still. The frequent repetition only makes matters worse, while one sudden, and sufficiently vigorous, well-directed wrench would remove the cause, once for all.

The pain in chronic tenosynovitis is very variable; usually it is rather of a dull, aching character, with a sensation of soreness; it is never intense and throbbing, as in the acute form. The temperature is only slightly raised, there is little or no redness of skin, but the swelling is generally conspicuous, involving the loose tissue around as well as the sheath itself, and attended with great impairment of power. In many cases the effusion is simply serous, but it may be thickened, almost gelatinous, or mixed with myriads of melon-seed bodies, all practically the same size and shape, consisting of concentric laminæ of fibrin, developed from the lymph poured out on the walls and septa. The inner surface may retain its normal smooth character, but not unfrequently, especially in rheumatism and in the neighborhood of joints affected with osteo-arthritis, it is rough, irregular, and covered over with masses of dendritic outgrowths, which can be felt rustling and crepitating with every movement.

Tubercular inflammation is met with most frequently in the large sheaths which spread along the flexor tendons under the annular ligament of the wrist. The walls and mesotena are enormously thickened and converted into granulation-tissue, similar to that met with in tubercular synovitis of joints. The fluid in the interior may be gelatinous, like that found in ganglions, or turbid from the exudation mixed with it; but it is rarely much increased in quantity. The lining membrane is softened and rough, the movements of the tendons impaired, and the use of the part greatly limited. The most prominent symptom is a chronic, painless swelling, occurring, as in compound palmar ganglion, above and below the annular ligament of the wrist, soft and elastic to the touch, but not fluctuating, and not admitting of its contents being driven from one compartment to another.

3. *Suppuration.*—This may be caused by direct infection, as after amputation of the toes when long open channels are left, placed vertically in the most convenient position for receiving all the discharges of the wound; or by pyæmia, or by extension from inflammation near. The most common situation is on the fingers (*thecal abscess or whitlow*), owing to the frequency with which poisoned

wounds occur, and the peculiar distribution of the lymphatics. Instead of the loose, horizontal arrangement which prevails in the subcutaneous tissue of other parts, the general direction of all the fibres and lymphatic spaces in the fingers is from the skin toward the periosteum or the tendon-sheath, and any poison that is inoculated on the surface is carried down to the deeper structures, causing inflammation, which is all the more severe because of the dense, unyielding character of the tissues. This is the explanation of the frequency with which periostitis of the last phalanx and acute suppuration in the tendon-sheath occur. The poison spreads down to the bone, which speedily becomes inflamed and perishes (the proximal end and the joint often remaining intact), the tendon sloughs, and the finger is left distorted, stiffened, and useless. Fortunately the sheath, in the case of the first three fingers, does not communicate with the general one, but extends no further than the heads of the metacarpal bones. In the thumb and little finger, however, it does, and if acute suppuration occurs in connection with them the sloughing is very likely to involve the whole of the flexor tendons, the hand may be riddled with abscesses, and the pus may spread into the carpal joints, or even in the deep planes of the cellular tissue up the forearm, and endanger life itself.

Owing to the extreme tension, acute suppuration in the tendon-sheaths of the fingers is attended with very severe symptoms. There may be a rigor; the temperature is raised many degrees, the finger throbs and burns, especially if it is allowed to hang down, the skin is hot, glazed, and exquisitely tender, and movement is impossible. For the same reason, the dense character of the tissue on the palmar surface, the swelling is usually slight. Often it is more marked upon the back of the hand, the poison passing from the sheath into the cellular tissue around, and in severe instances it is accompanied by lymphangitis and deep-seated, brawny infiltration of the tissue of the forearm.

On the other hand, in pyæmia, suppuration may make its appearance in some loose and large sheath as insidiously as in the case of joints, without tension, redness, or pain. The consequences, however—the extension into the cellular tissue round, and the implication of neighboring synovial cavities—are no less certain when once the resisting power of the tissues is overcome by the continued action of pyogenic germs.

**Treatment.**—The general principles are the same as in the case of joints. When the symptoms are acute the limb should be placed upon a splint, kept at perfect rest, raised to check hyperæmia, and carefully and evenly bandaged, the line of the sheath being covered with many layers of cotton-wool. If this is not practicable, cold or lead lotion may be used. Passive motion should be commenced as soon as there is a sensible reduction in the quantity of the effusion, moving the tendon once or twice each day quietly and steadily will prevent the formation of adhesions without making the inflammation more severe.

As the attack subsides, counter-irritation may be used with benefit. Massage, owing to the peculiar situation of the tendon-sheaths, is of especial service. Hot douching, steaming, fomentations, friction, and passive motion are of very great use as soon as the temperature of the part is normal. Sometimes, particularly when there is one very tender spot, an adhesion can be ruptured under an anæsthetic and the tendon released. In most of the cases, however, in which there is persistent stiffness, it depends not so much upon the presence of bands and adhesions as upon the defective state of nutrition. The tendons and their sheaths have been injured and kept at rest for weeks together; the circulation through them has been reduced as low as possible; the plasma upon which their nutrition depends has been allowed to remain stagnant in the interstices, and active work is out of the question. Under these conditions, when once the acute inflammation has subsided, and the temperature of the part has fallen to normal (very often it is lower than this, and the skin is blue and congested), everything is beneficial that encourages the flow of blood through it; the more it is used the sooner it recovers.

If there is a suspicion of suppuration, an exploratory puncture should be made

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Tubercular disease of the synovial sheaths of tendons should be treated at first by rest and pressure, in the hope that if all sources of irritation are avoided the tissues may gain the upper hand and the tubercles undergo retrogressive changes. If this does not succeed, excision may be practiced with success, even in the case of the compound palmar ganglion. The whole sheath has been laid open from one end to the other, the anterior annular ligament divided, and the thickened, softened, gelatinous tissue carefully dissected out, as in arthrectomy. The structures are then sutured together in their proper order, an opening left at each end for drainage, and passive motion begun on the second day.

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A simple ganglion forms a round, tense swelling, which stands out, white and prominent, beneath the skin when the tendon is put upon the stretch. As a rule,

they are too small for fluctuation; many of them feel as dense and elastic as a lage, but not unfrequently their consistence varies from time to time; thos example, that occur by the head of the fibula are distinctly softer when the is bent than when it is extended. They are not painful and there is no si inflammation about them, but they may cause considerable suffering from pre upon a cutaneous nerve; and very often they are attended by a sensati weakness, although there is no proof of actual loss of power and no wasti the muscle.

No definite line can be drawn between these and those that are due to d tion of the synovial sac itself. Many of the cystic ones are large, thin-w and lobulated, evidently occupying a considerable portion of the general ca and as they grow they become even more irregular in shape. The most impo is that which involves the sheaths of the flexor tendons of the fingers (Fig. The arrangement of these sheaths is subject to great variety, not only in diff persons (arising possibly from different occupations) but at different ages. is a separate sac for the flexor longus pollicis, which, after childhood, opens communication with the phalangeal one, so that one long cavity extends fro last phalanx to some distance above the wrist. Similarly in the adult there common sheath for all the flexors of the fingers, but this opens into the phala sheath of the little one only. In old age, especially in those whose hands

FIG. 84.—Ganglion Involving all the Flexor Tendons of Hand and Wrist.

been subjected to much work, the barrier between these two sheaths breaks do and a very irregular space is left, with numerous septa dividing it into imper compartments. According to other observers (Rosthorn in particular) in ch hood and frequently in adult life the index and middle finger tendons are de of a sheath altogether, and there is but one for the ring and the fifth. How this may be, it is not uncommon as a result of repeated strains to find an enor swelling filling up the palm of the hand, so that the fingers cannot be clo extending along the little one, and sometimes the thumb as well, right to the and communicating freely with another swelling above the annular ligament o wrist, reaching upward for two or three fingers' breadth. If the wrist is fl and pressure is made alternately above and below, the fluid can be squeezed one part to the other, and not unfrequently with it numerous melon-seed bo which can be felt crepitating among the tendons as they pass across. Th known as compound palmar ganglion. It may be caused by a single strain; in most instances it is of gradual formation. There is no heat or redness, there is a certain amount of chronic inflammation which leads to the irregular th ening of the walls and mesotena, and to the deposit of the lymph out of w the melon-seed bodies are formed; and occasionally when the irritation is kep it ends at length in suppuration.

Similar changes occur in connection with other tendon-sheaths, the syn

of the peronei, for example, or that for the extensors of the toes, but much more rarely.

**Treatment.**—Cystic ganglion, if it gives rise to any inconvenience, may be treated in various ways. Subcutaneous rupture is often resorted to, but the cyst generally refills, and when it does not it leaves behind a thickening which may persist for years. Puncture with a trocar and cannula is not more satisfactory. Subcutaneous section with a tenotomy-knife, dividing the sac in two with a single horizontal sweep, answers better; but if the cyst causes any real trouble or is unsightly, the most efficient plan is to cut down upon it and excise it. The cure is effectual, and a linear cicatrix only is left. The limb should be placed upon a splint afterward, until the wound is sound, as not unfrequently the tendon is exposed, and sometimes the cyst communicates indirectly with a neighboring joint.

Compound ganglion is much more serious, and if the walls of the synovial sac and the septa are thickened and irregular, or if they are covered over with lymph, and the cavity is full of melon-seed bodies, a very guarded prognosis must be given. Pressure is of no use. A free incision may be made into it above and below the wrist, and the whole cavity emptied and drained as thoroughly as possible; but though the fluid is removed, and most of the melon-seed bodies, many are sure to be left, the condition of the lining membrane is untouched, and the drainage is very imperfect. Syme laid the whole sheath open, dividing the annular ligament; and it is a question whether this would not be the best proceeding now, at least for those cases in which melon-seed bodies are present and the walls are much altered in character.

The greatest care must be taken to avoid suppuration. If this occurs, the tendons are almost sure to slough; and if there is the least tension, or if the vitality of the tissues is lowered by the poisonous products of decomposition, it is almost certain to become diffuse and to spread to the wrist joint, or to the deep planes of cellular tissue in the forearm, and cause the most extensive destruction.

## Dupuytren's Contraction.

The palmar fascia, and the prolongations of it which run by the side of the fingers and are attached to the periosteum of the first phalanx, not unfrequently become the seat of a peculiarly obstinate form of contraction, tying the fingers rigidly down into the palm of the hand. It rarely occurs under thirty years of age, and is much more common among men than women; indeed, according to some, the latter are entirely exempt, but this is not the case. Usually its beginning can be traced to some slight injury, such as the pressure of a round-headed stick in the palm of the hand during convalescence from severe illness; or a sudden strain, pulling the finger back; but there is no doubt that it is dependent, to a very large extent, upon gout, although I am not aware that deposits of urate of soda are ever found in it; and it is much more common among the well-to-do than among hospital patients. Certain classes of the latter, however, engineers' fitters, for example, are often affected (Fig. 85).

Fig. 85.—Dupuytren's Contraction.

The ring finger is usually attacked the first, but in many cases all the three on the ulnar side are involved more or less; the index only suffers in the worst. The first thing to attract attention is a small, hard nodule in the palm of the hand, at a point corresponding to the lowest of the transverse creases into which the skin is thrown and to the interval between the ring and [illegible] fingers. It is not painful unless roughly handled, and does

not at first give rise to any inconvenience. Soon, however, the skin begin waste and lose its flexibility; the fat disappears, and the cutis becomes tied d so firmly to the fascia beneath that it is practically incorporated with it. T prolongations make their appearance, running from this upward toward the and downward to the fingers. The skin becomes adherent in other parts; bands of fascia stand out more rigidly, and gradually the fingers are flexed tied down into the palm of the hand in an altogether hopeless way. Extens has not the least influence over them.

The flexor tendons take no share in the deformity, although at first sight it easy to mistake the rigid bands that stand out in the hollow of the palm for the The disease is entirely due to the contraction of the fascia, the deep as well the superficial layer, and the vertical bands that pass between them and the ski It affects the fingers on the inner side of the hand more than the rest, because i all probability they are weaker and less able to stand a strain than the other and if they are bent backward the prolongations of the fascia over the metacarp phalangeal articulations are stretched and hurt. It is the peculiarly obstina and progressive character of the contraction that makes it so serious. Whe once it has commenced, it tends steadily to grow worse and worse, tying on finger down after another; and although in the earlier stages it may be relieve or even cured without great difficulty, in the later ones this is impossible witho operation.

**Treatment.**—Systematic massage, with the finger well extended, will ofte check the contraction, if not too far advanced, and cause absorption of th inflammatory exudation. If this does not succeed a splint may be worn at night fitted on to the dorsum of the hand and firmly strapped to the wrist. Litt caps of metal are adjusted to the phalanges and attached to the dorsal splin by means of elastic bands, the strength of which the patient can regulate fo himself.

In other cases a more complicated appliance is required. A broad, well-padded metal plate is fitted to the back of the hand and wrist, with extension racks lying over the fingers bent at an angle to suit the degree of flexion. Improvement, however, in this way is very slow, and it rarely happens that patients can be induced to take the trouble before the deformity is too far advanced and the bands too rigid. If the angle of flexion approaches 90°, it is almost impossible to straighten it without operation.

Dupuytren himself merely made a transverse incision through the skin and fascia at the most resisting point, so that when the finger was straightened out a lozenge-shaped wound was left, the sides of which might in successful cases grow together. Modern treatment, however, resolves itself either in subcutaneous section with a fine tenotomy-knife at many points (after Adams), or into a modification of Goyrand's original plan, dissecting out the whole of the contracted portion. Whatever is done, it must be recollected that unless immediate unio is obtained the result is likely to be very far worse afterward than it was before.

When the bands extend far down the sides of the fingers, there is no doub that Adams's method is preferable. The hand should first be thoroughly soake in an antiseptic bath and well raised, so as to limit the amount of hemorrhage The palm is dealt with first, selecting those points where the skin is still movabl over the subjacent tissue; then each side of the fingers by itself, as many punc tures being made as are necessary to allow them to come out perfectly straigh The little wounds are then covered with iodoform-collodion and cotton-wool, palmar splint adjusted to keep the hand at rest, a bandage placed over the whol and everything left for three days. By that time all the punctures should b healed, and extension may be commenced with an appliance similar to that alread described. The more rapidly this is carried out the better; to be successful th fingers should be perfectly straight within the fortnight.

Excision is only practicable where the contraction is of limited extent, an such cases, of course, succeed the best with tenotomy as well. The incision i

de down the length of the band; the skin, which is usually very much atrophied d closely adherent, detached from the fascia beneath without bruising; and en the hard, contracted band isolated and removed. The advantage of this thod is that the straightening is more perfect and the risk of recurrence is s; but it is very questionable whether this is real. Certainly some of the cases hich have apparently succeeded have relapsed again in an altogether hopeless nner.

Whichever method is adopted the apparatus must be worn at night for some considerable time to prevent recurrence. During the day it may be dispensed with as soon as the fingers are straight. Massage, warm bathing, deep friction, and everything that can encourage absorption should be thoroughly practiced from the moment that the wounds are sufficiently sound. Nodules and deep bands of the fascia are always left behind, even when the attempt at excision is fairly successful; and every endeavor should be made to promote their absorption, to limit the amount of inflammatory exudation, and to restore as soon as possible the suppleness of the skin.

## BURSÆ.

Bursæ are spaces developed in the cellular tissue by friction. The deeper ones, lying between tendons and bones, are present at birth, and are lined with a definite endothelium similar to that in tendon-sheaths and joints. Subcutaneous ones, on the other hand, do not, for the most part, make their appearance until later, and are less regular in shape and structure. Many are constant in occurrence, and are reckoned among the normal structures of the part; but they may be developed anywhere by friction, and throughout life they have a tendency to grow, until in many cases they form communications with neighboring synovial cavities. The fluid in the subcutaneous ones is more serous than joint synovia, but that in the deeper ones is identical with it.

Bursæ that communicate with joint-cavities naturally possess a special importance. Very often the channel between the two is so narrow that no fluid can be made to traverse it; but where there is the least ground for suspicion, the swelling should always be given the benefit of the doubt, and treated as if it were an outlying part of the synovial sac.

*Injuries.*—Incised and punctured wounds inflicted with a clean instrument heal readily. The latter are the more serious, owing to their tendency to become valvular. Lacerated ones may cause considerable trouble, owing to the fact that the part is the seat of constant friction. For the same reason contusions are frequently followed by slight inflammation. No special treatment, however, is required; if there is a wound it must be thoroughly cleansed and drained; a large extravasation of blood may be aspirated; and in any case careful pressure must be used to prevent tension and to keep the parts at rest.

*Inflammation of Bursæ.*—Simple inflammation is very common. It may be acute or chronic, and subside or end in suppuration. Specific diseases are more rare, but superficial bursæ in particular are liable to be affected in syphilis, gout, and tubercle, probably owing to the frequency with which they are injured.

(*a*) *Acute Inflammation.*—This is nearly always due to injury. The symptoms, if the bursa is superficial, are plain at once. Swelling is very conspicuous; and redness and local pyrexia are well marked; but owing to the presence of a cavity in which the exudation can collect the tension at first is not very high, and the pain and constitutional disturbance not severe. In deeper ones, on the other hand, the diagnosis is more difficult; swelling cannot be detected; the pain is often very great, especially on movement; and the fever may be such as to lead to the suspicion that other even more important neighboring structures are involved.

In these cases the diagnosis often rests almost entirely upon a knowledge of the action of the muscles that surround the part. Thus, if the bursa under the deltoid is inflamed, rotation of the humerus is fairly free when the arm is moder-

ately abducted from the side; in adduction or great abduction it is very pain owing to the tension upon the sac. So with that under the psoas; if the thigh flexed the head of the femur rotates without pain. On the other hand, the li is kept extended when either the bursa between the quadriceps and the femur, that between the ligamentum patellæ and the tibia, is affected. In other cases t position of the swelling is the most significant sign. If, for instance, the bur between the os calcis and the tendo-Achillis is enlarged there is a swelling on either side behind the limb, but none in front, as when the bone or the ankle joi is inflamed; and unless the bursa on the front of the pouur communicates with th knee joint there is no distention of the synovial fcemhes on either side of th patella, even if it suppurates.

(*b*) *Chronic Inflammation.*—This may either be the result of an acute attac or be chronic from the first. Usually it is caused by some slight but frequent repeated injury, or by a more severe one (a contusion, for example, filling it wit blood), the effects of which are perpetuated by constant friction.

The pathological appearance varies very considerably. Sometimes the wall thin and the cavity immensely distended with a fluid which at first is blood-staine but which in course of time loses its color and becom clear and serous. In other cases the wall is thicken (whether there is fluid present or not) either by the depo of fibrin in laminæ on the inner surface or by the formatic of dense inflammatory tissue around, or by both togethe until it is an inch or more in diameter, and the centr cavity is reduced to a cleft (Fig. 86). It rarely disappea altogether. Not unfrequently the interior is rough ar irregular, covered with warty nodules, or traversed b thickened bands, some of which, as in the case of the pra patellar bursa, may be the remains of the septa between th different cavities, while others are new formations altogethe Occasionally melon-seed bodies are found in number either white or stained with blood, as if they were formed from blood-clo More rarely there are definite pedunculated outgrowths with floating cartilaginou ends, similar to those found in joints. This, however, is not common except i osteo-arthritis, when the bursæ, even though they do not communicate with th neighboring joint, not unfrequently undergo a similar transformation. Finally sometimes, in very old cases, calcification takes place.

Fig. 86.—Semi-solid Bursa Laid Open.

Tubercular inflammation is characterized chiefly by a slow, painless enlarge ment, due to the accumulation of fluid mixed with flakes of caseous material. Th interior is lined with pale, flabby granulation-tissue containing giant cells, but fe bacilli. Sometimes, especially in the case of the sub-gluteal bursa, these cavitie attain a very large size, and spread for considerable distances among surroundin structures before they break; and then they are prone to leave behind them chron sinuses covered by flaps of purplish skin. Usually they require the free applic tion of the cautery or of Volkmann's spoon before they get well.

Syphilitic disease chiefly occurs round the knee and over the tuberosity of t ischium, owing in all probability to the great liability of these parts of the bo to injury. The gummatous deposit breaks down, leaving round, punched-c openings with overhanging edges. In gout the bursa that forms over the metatars phalangeal joint of the great toe is the one that suffers most frequently, but occ sionally deposits of urate of soda are found in the interior of those in other pa of the body.

(*c*) *Suppuration.*—The onset of suppuration in a bursa is usually marked eith by a rigor or by a sudden rise of temperature with severe throbbing pain. T swelling rapidly increases in size; the skin becomes boggy and œdematous; a if free exit is not given at once the walls of the bursa give way, the pus spreads and wide in the softened and hyperæmic connective tissue around, and diffu inflammation of the cellular tissue follows. In part this is due to the difficul

the pus has in escaping through the dense layer of tissue that has been formed over the cavity by constant friction; in part to the fact that, after all, a bursa, even when it is surrounded by a wall of its own, is only a space in the cellular tissue, and is in free communication with all the interstices around. Usually the neighboring lymphatic glands are involved as well, and sometimes, especially in the case of the bursæ over the olecranon and the patella, the mischief spreads into the bones, and even by direct extension into the synovial cavity of the joints.

**Treatment.**—Acute inflammation must be treated by rest, cold, and pressure. [Hot antiseptic fomentations are serviceable in these cases.] In most cases it is advisable to place the limb upon a splint, and when the lower one is concerned to confine the patient to bed. If this does not succeed and the swelling does not subside, it should be punctured and the fluid let out to prevent suppuration.

Simple distention, if the wall is thin, may be treated very successfully by tapping with a trocar and cannula, and applying pressure afterward; or, if the case has not lasted long, and the part is conveniently situated, pressure alone may be tried first. Counter-irritation (the free application of blistering fluid) sometimes effects a cure. The injection of iodine is strongly recommended by some; but the limb must be placed upon a splint, and careful watch kept that the reaction does not go too far. In such cases the walls are probably well-defined, but if the iodine should escape into the cellular tissue, it is not unlikely to cause a considerable degree of inflammation.

When the wall is much thickened, measures of this kind are of very little use. It is better, if the bursa is unsightly or causes any inconvenience, to excise it altogether; and this is certainly advisable when foreign bodies are present, unless they can be thoroughly cleared out by free incision.

Deep-seated bursæ are so frequently in communication with neighboring joints, especially when they become enlarged, that very great care is required in dealing with them. The most treacherous of all, perhaps, is that which appears sometimes along the inner border of the popliteal space. When the knee is extended it forms a firm, elastic swelling, owing to the tension of the semi-membranosus and the inner head of the gastrocnemius between which it lies. In flexion, on the other hand, it is so soft and flaccid that it can scarcely be felt; but neither in one condition nor the other is it possible to prove or disprove whether it has a communication with the joint. Fortunately, in these deep-seated bursæ the more serious consequences, such as the formation of loose bodies and suppuration, are of rare occurrence; but even chronic distention causes a very unpleasant sense of weakness and greatly impairs the utility of the limb. Sometimes, moreover, as they grow larger they approach nearer the surface (the pressure in their interior increases in proportion to their size), and then, like the synovial diverticula they so much resemble in structure, they may either point beneath the skin and be opened by mistake, or may actually cause it to rupture and give way. In cases such as these aspiration and pressure should be tried first; but if these fail, and the cyst is accessible, it is better to cut down upon it, excise it, and stitch the neck up with catgut, than to resort to measures calculated to excite inflammation.

In the case of suppuration, free incision as soon as possible is the only course. Very often more than one is necessary, and not unfrequently, especially in the case of the knee, they must be made some little distance from the actual bursa, down by the side of the limb, so as to tap the cavity at its lowest point. Recovery in such cases is always exceedingly slow. Sloughs of fibrous tissue often have to separate; the skin is extensively undermined; the part, even in the case of the knee joint, is very difficult to keep at rest; matter will collect in outlying pockets, which have to be drained; and even when recovery is apparently ensured, not unfrequently as soon as the joint is used, some of the old cicatrices break down again. If the suppuration has extended to other structures—if, for example, the bone beneath is exposed and carious—repeated operations may be required before it is sound enough to stand friction and pressure.

# CHAPTER VI.

## *INJURIES AND DISEASES OF BONES AND JOINTS.*

## SECTION 1.—MALFORMATION AND DEFORMITIES OF THE LIMBS

### Disproportionate Growth.

Overgrowth, involving either a limb or one part of it only, is not uncommo The condition is present at birth, but naturally becomes more noticeable as a advances. One foot may be many times larger than the other, or one or two to only ; one or two fingers in each hand may grow until they are three or four tim the natural size, and occasionally this is almost symmetrical.

On the other hand, there may be congenital absence of the whole or part one of the bones ; the radius, for example, may be wanting, or the tibia or fibul causing very severe distortion of the foot or hand as the case may be, and associat occasionally with defect of the corresponding digits ; or one end may be develop and not the other. Deformities this nature are, as might be expecte often associated with other defec mental as well as bodily, but th occur as well in people who are in other respects well formed and w developed.

Fig. 87.—Supernumerary Thumb.

Supernumerary fingers and to are occasionally met with, partic larly in connection with the thum If they are merely attached by a pec cle of skin, it may be divided at once ; but in all other cases a careful examinati should be made first, as not unfrequently the synovial membrane of the joint th belongs to the supernumerary finger communicates with that of the normal o (Fig. 87).

### Congenital Dislocations.

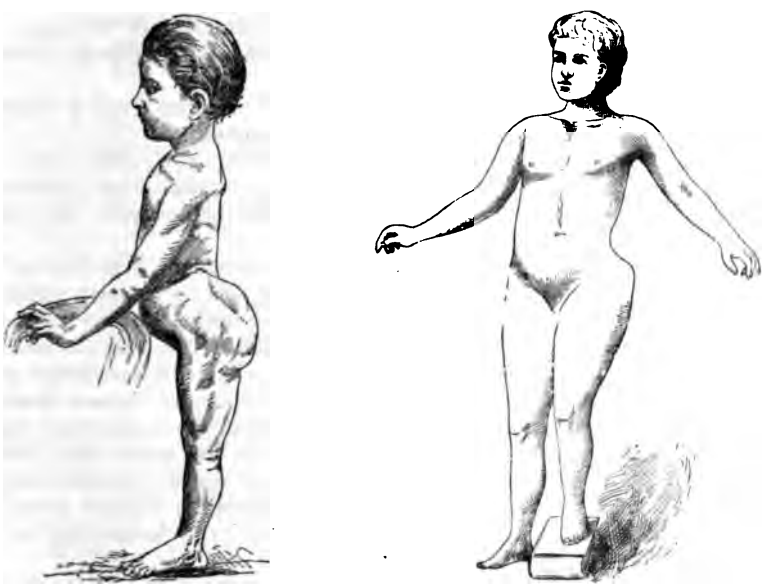
This name has been given to a peculiar deformity, which is of common occ rence at the hip joint, and is occasionally met with elsewhere. Instances of it ha been recorded in connection with the shoulder, elbow, wrist, fingers, knee, patel ankle, toes, and even the lower jaw ; but in many of these other more grave defe were present as well. Like similar deformities which do not involve joints, it m exist in many grades ; it is rarely noticed at birth, and it becomes more and mc marked so long as the period of growth lasts. ["It is probable that congeni displacements may occur in all the articulations of the skeleton ; in most them their existence has been established by dissections."—Frank Hastin Hamilton.]

The chief interest is in connection with congenital dislocation of the hip joi The limbs at birth appear well developed and in most cases there is no suspici that anything is wrong until the child is a twelvemonth old ; possibly there slightly greater difficulty in abduction than usual, but not sufficient to attract t nurse's attention. Walking, however, is unaccountably delayed, and even wh the child begins to move about, its action is exceedingly awkward and insecu On examination it is found that there is an unusual prominence in the glut region, that extension and abduction are unduly limited, and that the head of t femur can be made to slip up and down upon [redacted]rsum ilii

When the child at length does walk, the deformity, provided the affection i bilateral, is exceedingly characteristic. The normal rounded shape of the glutea region is lost, the trochanters are pushed up far beyond their proper level, an form a great projection over the ilium; the basis of support for the pelvis i shifted backward, the front part of the body projects, the shoulders are throwi back, and in other words there is extreme lordosis with an unusually protuberan abdomen. In many instances this is associated with considerable inversion of th limb and flat-foot.

If one side only is affected the deformity is even more conspicuous, owing t the difference in length of the legs, and consequent tilting of the pelvis and latera curvature of the spine. When the child is lying on its back the malformation i much less distinct, and at first at least the head of the femur can be drawn dow nearly to its natural situation (Figs. 88 and 89).

Formerly this was attributed to traumatic dislocation occurring at birth, an



CONGENITAL DISLOCATIONS OF HIP.

FIG. 88.—Double. FIG. 89.—Single.

it was pointed out in support of this view that it was much more common in breec presentations than in others; and that the extreme shallowness of the acetabulun would undoubtedly favor it. Without, however, denying the possibility of such a occurrence (in one or two cases a distinct slip has been felt at the time), there ca be no doubt that this is not the ordinary cause. It is very doubtful whether it i really more common in these presentations; in the majority of cases the birth i described as having been particularly easy; the affection is often bilateral, it ma be hereditary, and it is seven or eight times more frequent in female children tha in male.

Opportunities of examining the interior of the joint are not common, and i all the cases hitherto the patients have either been adults or at least have walke for some time, so that secondary changes had developed. There is, however, fair amount of agreement among them; the iliac portion of the acetabulum is want ing, either altogether or in part; the cavity itself is very small and triangular i shape; it may be lined to some extent with cartilage, but it is much too shallow t

accommodate the head of the bone. The ligamentum teres is usually present (i occasional disappearance is probably secondary); the capsule is strongly develop and contains the head of the bone, although, of course, it is immensely stretch The upper extremity of the femur is rather smaller than natural, somewhat fl tened, and rests in an imperfect socket upon the dorsum. The lower part of th innominate bone is narrow and elongated, the ischial tuberosity everted, and it ramus twisted, and the glutei muscles (especially the maximus), are usually con siderably wasted.

It is possible that this may be caused by extreme distention of the synovial sa *in utero*; there is no doubt that, even when the head of the femur fits much mor securely in its cup than it does at that period of life, dislocation within the capsul can be produced in this way, the fluid penetrating between the articular surface until it separates them from each other; and it is also true that reparative process are carried to a much greater extent of perfection in intra-uterine life than after ward: but certainly for the majority there is no more evidence in favor of thi view than there is in favor of traumatic dislocation. Sometimes it is associated with what has been called genu recurvatum—hyper-extension of the knee, caused by fixed malposition *in utero*; but there is no proof that this is present in ordinary cases.

In comparison with this, congenital dislocation of other joints is exceedingly rare, that of the humerus being perhaps the most common.

The diagnosis rarely presents any difficulty. After acute epiphysitis in infant the limb sometimes assumes the same position and direction, owing to the head o the bone having been destroyed; but the history and the cicatrices are sufficien evidence.

**Treatment.**—It rarely happens that this deformity is detected until some considerable time after birth, so that even if it were due to traumatic dislocation during parturition any attempt at reduction would be futile. In the vast majority of cases little or nothing can be done for it. Continued extension, however, kept up for a twelvemonth or even longer, has been followed by improvement more or less permanent. In other cases, pelvic bands and supports of various kinds have been worn to transfer some of the weight directly on to the trochanters either by vertical or circular pressure, but such accurate and at the same time constantly varying adjustment is required that it is very doubtful if any real benefit is conferred. In the worst cases (and they differ very much in severity) Ogston recommends the formation of a new cavity in the proper situation, and dovetailing the femur into it.

If it is unilateral a high boot must, of course, be worn, to obviate twisting of the pelvis and lateral curvature of the spine.

### Club Hand.

A distorted and deformed condition of the hand is occasionally met with birth, consequent on defective development of one of the bones of the forearm Very rarely it is due to muscular rigidity or contraction of the palmar fascia. I a few cases a certain amount of benefit is obtained by tenotomy and the use splints; but in the majority it is beyond remedy.

### Webbed Fingers and Toes.

In this malformation the double fold of skin which should be limited to th angle between the digits is prolonged downward along the sides until in some cas it reaches the whole length (Fig. 90). Very often it is symmetrical, and some times, in the worst cases, all the fingers are united.

Division is apparently a simple matter, but unless proper precautions are take

union from the angle onward is almost sure to occur. It has been recommended to make a hole through the web as far back as possible and insert a metal ring, in order that thorough cicatrization may take place first, and then the rest can be divided without fear, but if there is sufficient thickness of tissue a plastic operation is preferable.

FIG. 90.—Webbed Fingers.

In one fashion (that of Didot) an incision is made along the dorsal surface of one finger and the palmar of the other, and the flaps of skin so marked out are reflected toward each other until they meet in the middle. The division is then completed, and the flaps carefully wrapped round and sutured in position, the dorsal one, for example, reaching round to the palmar surface of the same finger and *vice versa*. This, however, is rarely practicable unless there is a good thickness of tissue available, and the longitudinal cicatrix running down the middle of the palmar surface of one finger is not unlikely to lead to a very obstinate variety of contraction.

In Agnew's method a dorsal flap, triangular in shape, is cut from the upper surface of the web. The apex corresponds to the free margin, the base to the interval between the proximal ends of the first phalanges. This is reflected backward on to the dorsum of the hand, the rest of the web divided as far back as necessary, and then it is folded over, in between the fingers, so as to fit into the gap. The edges, both of the reflected flap and of the wounds down the sides of the fingers, must be sutured accurately so as to ensure primary union.

## CONGENITAL TALIPES.

There are three primary varieties of this deformity.

1. *Talipes Equino-varus.*—The heel is raised, the inner edge is drawn upward, and the sole is twisted inward so that the patient stands upon the outer side of the foot, or in extreme cases upon the dorsum and the outer ankle (Fig. 91).

2. *Talipes Calcaneus.*—The toes are raised and the heel depressed, so that this part only of the foot is brought into contact with the ground.

3. *Talipes Valgus.*—This is the opposite to varus, the foot being so twisted that the outer side is raised and the patient walks upon the inner ankle. Occasionally it is associated with equinus or calcaneus (equino-valgus or calcaneo-valgus), but it is very much more rare than the others (Fig. 92).

Congenital absence of the tibia or the fibula gives rise to a form of talipes, which must not be confused with the preceding, in which the bones are present.

**Causes.**—Congenital talipes in the vast majority of instances is merely an arrest of development with persistence of growth, similar to cleft palate and other malformations. The parts retain the relative position that is natural to them at different periods of fœtal life, slight modifications following as the size of each increases.

The cause of the arrest is unknown. In exceptional instances it may be due to pressure, as suggested by Parker and Shattock, the foot being confined in some irregular position, so that the natural evolution of the limb cannot take place, just as genu recurvatum can be produced in the fœtus by persistent extension of the knee; but in the majority no evidence of such confinement exists, the parts are as well grown (in point of size) and the skin as natural as in ordinary feet.

Like other malformations, it is not unfrequently hereditary, and often

descends in the father's line. In a certain proportion of cases it is associated w spina bifida and other defects, and on this the argument has been based t because they occur together, one is the cause of the other. The muscles nerves going to the part have been examined many times, but in nearly ev instance their structure has been perfectly normal, and with the above-mentio exceptions, the same may be said of the spinal cord.

**Pathology.**—In talipes equino-varus the foot retains the position it assu about the sixth week, when the hip and knee are flexed and the feet meet over t lower part of the abdomen and cross each other. In talipes calcaneus t deformity is much later, dating from the time when the feet are bent upward wi the dorsum resting against the front of the leg, and the normal unfolding of t part is not interfered with. The earlier the date at which the arrest takes plac the worse the deformity.

The chief change is in the astragalus, and particularly in the obliquity of i neck, which retains the direction that is normal in anthropoid apes. This measured (Parker and Shattock) by means of two threads stretched over the bo when placed upon a horizontal surface. One passes from before backward ov the middle of the trochlea, at right angles to its transverse diameter; the oth along the outer edge of the neck. The angle that the two make with each oth in front is the measure of the deviation. In adult specimens the mean was fou to be 12°; in the fœtus at full time 35°; in varus 49°; and in a young orang 4 (it is less in the adult). In other words, although the difference in the vario

FIG 91.—Congenital Varus. Three Grades of Severity.

FIG 92.—Congenital Valgus.

specimens was considerable, these observers found a regular gradation from th earlier periods of life to the later, and showed that the deformity in talipes var was the worst, in talipes calcaneus much less. The position of the internal ma leolar facet, which runs nearly as far forward as that for the scaphoid in the fœt at full term and the anthropoid apes, may also be taken as an indication of t obliquity; in the former it recedes, in the latter it persists, though not in qui such a marked degree.

Defective development of the lower limbs is exceedingly common in childr at birth. The hips and knees in many infants cannot be straightened out f months; and the feet, although they can readily be brought into the proper lin and by degrees come to it of themselves, in the vast majority assume naturally t position of varus. In others there is a certain degree of calcaneus, which, ho ever, unless it is associated with other troubles, nearly always disappears spont neously. With regard to this latter deformity, as it does not appear, like talip varus, to have a persisting representative among the lower animals, it may possib be due to the accidental retention of the foot in one position; and perhaps th may account for the fact that it rarely requires much treatment. If this really the case there is a very distinct difference in origin between the two, the one bei due to retention of a normal developmental condition, the other to what may considered an accidental one, acquired late in the evolution of the race.

The amount of distortion in the common forms varies very considerably, a is immensely exaggerated if the child is allowed to bear its weight upon the fo in the deformed position. The tuberosity of the os calcis is drawn upward unt

direction is almost vertical; and at the same time it is rotated on its longitudinal axis until the greater process rests upon the ground. The astragalus is tilted forward, almost out from its socket, and its neck twisted even more. The scaphoid is drawn up to its inner side, leaving the front articulation and forming another for itself between the astragalus and the internal malleolus, while the cuboid is so twisted round that its dorsal surface may even rest upon the ground. The outer border of the foot becomes convex downward from the heel to the toes, the inner border is much shortened. The head of the astragalus is divided into two parts, an outer subcutaneous and an inner, almost at right angles with it, for the scaphoid; and the external malleolus is pushed far back, beyond the level of the internal.

The inferior calcaneo-scaphoid, and the anterior and middle parts of the internal lateral ligament of the ankle joint are very much shortened; the bands on the outer side, on the other hand, are stretched; and the tendons of the anterior and posterior tibial muscles are brought close together.

In the worst cases, those which have been neglected or have relapsed, the whole foot is shortened and stunted, the weight is borne upon the cuboid, the external malleolus, and the outer side of the anterior end of the os calcis; an enormous bursa or callosity is developed, covering the whole surface; and the metatarsal bones are so squeezed together that the transverse arch of the foot is narrowed, and a deep longitudinal furrow formed in the sole.

Analogous changes, but, as a rule, much less marked, are present in talipes calcaneus and in the rare form of congenital valgus.

**Treatment.**—Slight cases are treated by *manipulation*. If the foot comes easily into the proper position, and the muscles are well nourished, it will assume the normal position in course of time with very little assistance. The joints should be thoroughly worked and rubbed every night and morning, taking care that the foot is in plantar flexion when eversion is being practiced; and all that is needed is perseverance [during these measures, in the interval between the movements a fan-shaped adhesive plaster is applied to retain the foot in position, as suggested by Mr. R. Barwell.]

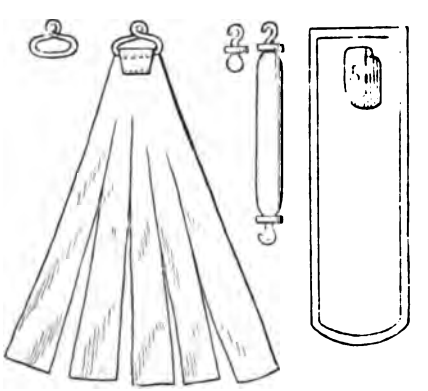


FIG. 93.—Barwell's Adhesive Straps, with "Rubber Muscle." (*After Sayre.*)

In every case it is essential to make sure that the varus is real. In many instances of apparent equino-varus, one-half of the deformity disappears as soon as the gastrocnemius is thoroughly relaxed; the traction of the tendo-Achillis has caused equinus, and the natural tendency to inversion, when there is nothing to prevent it, has led to the semblance of varus. If both are present, the equinus should be left to the last.

A combination of these two plans is very successful; a strip of metal being placed next the flannel, running up the side of the leg and under the sole of the foot, with a few turns of plaster bandage over it. Just before the plaster sets the foot is twisted outward a little and left. Careful watch must, of course, be kept upon the circulation in the toes.

When manipulation does not succeed, and yet there is no degree of rigidity, the foot may be twisted into the proper position by the hand, and fixed by means of a splint or plaster bandage, until the bones have grown into the normal shape. A flannel bandage is applied first, from the foot to above the knee. An outside metal splint (either of tin or zinc) is then fixed along the limb and the foot drawn out to it (still in the equinus position); or a plaster bandage placed over it, and

the limb held as near the normal as possible, without using too much force, u it is firmly set. A splint must be removed and reapplied at least every seco day, the skin being thoroughly well rubbed and sponged with spirit and w each time, so that there may be no redness; a plaster bandage may be left fo week, but it is not advisable to leave it longer. As soon as the varus is thorough corrected (or, better still, a little over-corrected, for it is sure to relapse somewha the equinus may be attended to; the object of leaving it is to give a better pu chase for the bandage, and to allow the anterior part of the tarsus and the os calc to move freely upon the astragalus. Nearly the whole of the inversion and eve sion of the foot takes place at the calcaneo-astragaloid articulation, very little a the mid-tarsal, at least on the outer side.

In a large proportion of cases this treatment, if persevered in, succeeds admirably; but in the worst, in which the sole of the foot is inverted and deeply furrowed, and the muscles and tendons stand out rigidly, something further is required.

[*Brisement Forcé.*—This consists in forcibly breaking all the resisting structures, either by the hand or by some one of the traction apparatus. The patient, being fully anæsthetized, is placed on a table and the foot upon a triangular, cloth-covered

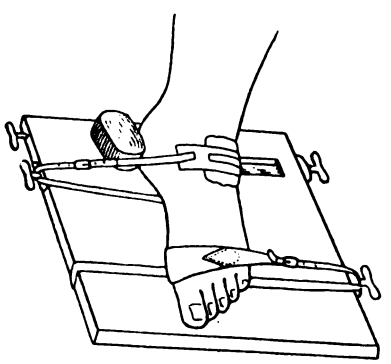


FIG. 94.—Morton's Club-foot Stretcher. (*After Bradford.*)

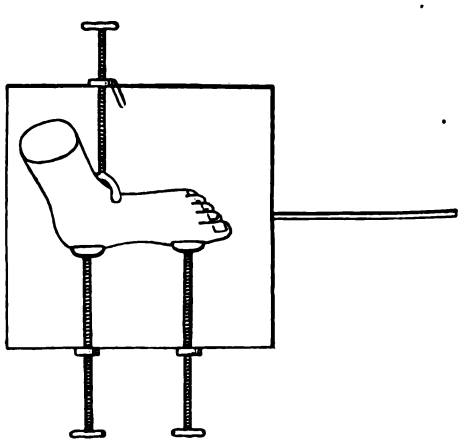


FIG. 95.—Bradford's Club-foot Stretcher.

wood-block. The operator grasps the foot, and by main force presses it against the block until all resistance ceases. Then the deformity should be over-corrected, on account of the constant tendency to recontraction. The foot is then firmly held in its corrected position and bandaged. Over this a plaster-of-Paris bandage is applied and allowed to remain for a period of ten to twenty days, according to the severity of the case. Morton's club-foot stretcher may be used instead of the hand in obstinate cases.

A certain number of club-foot cases may be well cured by brisement forcé, but so many relapses occur that tenotomy is certain to continue to be employed in the largest proportion of cases.]

The plantar fascia, the anterior and posterior tibial tendons, and sometimes the tendon of the flexor longus digitorum may require division; but *the only rule is to divide all soft tissues that stand out tensely and prevent rectification.*

*Tenotomy.*—Tendons and ligaments should be divided subcutaneously. A small puncture is made in the skin with a tenotome opposite the proposed seat of section (which, other things being equal, is the spot at which the tendon is thinnest and stands out most prominently), and either the same instrument or a similar one with a blunt point is passed with its blade on the flat behind the tendon

as a rule), while the assistant holds the limb in such a way as to relax the structures to be divided. As soon as it has passed a sufficient depth, the blade is rotated through a quarter of a circle and the cutting edge brought against the tough, fibrous tissue, the assistant meanwhile changing the position, flexing or extending as the case may be, so as to make everything tense. Then, with a gentle backward and forward movement, the fibres are cut through in successive layers, giving a kind of crisp sensation to the hand, until the resistance gives way. The separation should be distinctly felt, but there should be no jerk, for fear of sending the knife through the skin. As a precaution, the finger of the other hand should be pressed upon the surface in order that the presence of the blade may be detected as the skin is approached.

In other cases, if it is close to the insertion of the tendon, the knife is passed between it and the skin and the division practiced in the opposite direction. Recently the plan of open section has been advocated, on the ground that it is more thorough and complete, without being more dangerous; but it is questionable whether the supposed advantage this possesses is sufficient compensation for the time the wound takes in healing, even if there is no more risk.

Wounds inflicted with a tenotomy knife are dusted over with a little iodoform and covered with a piece of lint or cotton-wool and a bandage. As a rule, their site can hardly be detected on the fourth day, and suppuration is unknown. The tendon unites, like all other tissues, by the organization of vascular granulation tissue, springing chiefly from the sheath and the tissues around; itself contains so few blood-vessels that, like compact bone, it takes at first but little share in the proceeding; after a time it, too, becomes more vascular, and then the tissue that lies between the ends slowly shapes itself into the fashion of the structures it joins, and the tendon and its sheath are thoroughly restored. It is a matter of very great importance, so far as the immediate treatment of talipes is concerned, that this process of repair is practically independent of the distance between the ends, so long as it is not extreme.

The central and inner parts of the plantar fascia often require division, sometimes in more places than one; it is best accomplished by slipping the tenotome between the skin and the fascia and cutting toward the deeper structures. The tendinous part of the abductor hallucis may be cut at the same time by introducing the tenotome just in front of the inner tuberosity of the os calcis and cutting down to the bone.

The posterior tibial, the one that usually comes next, lies almost in the midpoint (from front to back) of the leg, just above the internal malleolus. Here it can be easily divided by making a puncture with a sharp-pointed tenotome right down to the tibia, withdrawing it, and passing a blunt-pointed one along its track (with its blade parallel to the leg) until the posterior border of the bone is felt. Then the tenotome is turned round, and the tendon that lies next to the bone, immediately behind it, divided, while the assistant forcibly everts the foot. If the incision is carried a little too far, the tendon of the flexor longus digitorum is divided as well; and, if further still, the posterior tibial artery. The hemorrhage may, however, always be stopped by means of a pad and a bandage.

In Syme's operation the tendon of the posterior tibial is divided just behind its insertion into the scaphoid, below and in front of the internal malleolus, against the bone; and if, as in many cases of club-foot, the anterior and middle bands of the internal lateral ligament requires section as well, preference should be given to this.

The anterior tibial presents much less difficulty, as it can always be felt, in cases of club-foot, standing out distinctly. The points usually selected are either immediately above its insertion, cutting down on to the bone, or higher up where it is prominent on the inner side of the front of the ankle-joint.

The tendo-Achillis (unless the case is equinus without varus, or with only the appearance of it) should be left until the foot is in a perfectly unfolded condition, in a right line with the leg. As soon as this is accomplished, it may be divided and the foot brought up.

The usual point is opposite the narrowest part of the tendon, not more than an inch above its insertion, in an infant. The foot is held by an assistant (the patient lying on the face) in a position of moderate plantar flexion; a puncture made with a sharp tenotome on one side or the other, according to convenience, and the blade of the instrument (parallel to the limb) pushed on until it can be felt under the skin, upon the opposite side. It is then turned round, the foot bent up toward the front of the leg to make the tendon tense; a finger of the left hand placed on the skin over it; and the fibres gently divided, rather by the pressure of the blade than anything else. Care must be taken that there is no jerk at the end.

*Division of the Ligaments.*—Recently, Parker, Sayre, and others have strongly advocated division of all resisting bands [and the plantar fasciæ], especially the shortened and rigid ligaments on the inner side of the foot. A curved tenotome with a short cutting edge is entered just in front of the anterior border of the internal malleolus, passed carefully, flatwise, between the ligaments and the skin, and then, by a gentle, sawing action, made to divide everything down to the bone. The foot must be rotated out by an assistant, so as to separate the malleolus as far as possible from the sustentaculum tali and the scaphoid. The same instrument is then gently pushed forward, close to the bone, on the plantar aspect, so as to divide the

FIG. 96.—Tin Splint for Slight Cases in Infants.

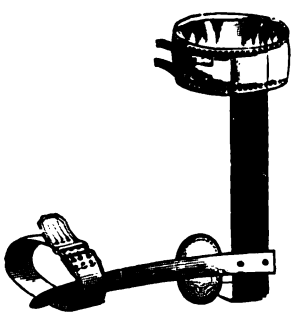


FIG. 97.—Little's Shoe for Slight Cases of Varus.

calcaneo-scaphoid ligament and the tendon of the posterior tibial. The long and short plantar bands are cut through from the outer side. A straight tenotome is passed in, opposite the calcaneo-cuboid articulation (almost, sometimes, on the sole of the foot), and carefully pushed inward, close to the bone, dividing the ligament as it goes.

*After Tenotomy.*—Until recently, it was always recommended that when the punctures were dressed, the foot should be carefully enveloped with a flannel bandage, and secured to a light splint made of flexible metal in the faulty position. It was feared that inflammation might set in, or that the ends of the tendons might be so far separated that union would not take place between them. In five or six days, when the little wounds were sound, the splint was removed and an extending apparatus applied, in order to stretch by slow degrees the lymph poured out between the cut ends. Parker, however, has clearly shown that there is absolutely no foundation for this; that the displaced position may be rectified at once with perfect safety, and that the long and tedious plan of treatment previously followed may be effectively supplanted by a much more rapid one. Thomas employs a foot-wrench, the prongs of which are covered with rubber, for the purpose of reducing deformity as rapidly as possible.

If this method of rapid reduction is adopted, all the tendons and ligaments that resist and stand out when the foot is brought into the right position are

ided; the punctures sealed with iodoform and a carefully picked layer of cotton-; a flannel bandage applied from the toes upward; and then, while the assist- holds the foot in as good a position as possible, a plaster bandage placed over whole. This is left for a week; at the end of that time it is taken off, the in thoroughly rubbed, and a fresh casing put on, pressure being used, as before, twist the foot outward into the normal line. The advantages of this plan over old one are obvious at the first glance. It may be commenced at once, within few days of birth, at a time when any appliance, such as Scarpa's shoe, or a tal splint, is practically out of the question; it avoids the evil effects of local ssure upon the skin, which only too often, when the older plan was followed, dered it necessary to interrupt the treatment for days or weeks together; it is rried out during the period when developmental changes are most active; the nger the case is left, the more difficult the deformity is to rectify, and it effects greater degree of improvement in weeks than the former plan did in months. s a rule, unless the case is very severe, the foot is practically unfolded by the d of the fourth or fifth week.

*Open Incision.*—Phelps adopts the same method, but divides everything in n open wound. An incision, an inch or two in length, according to the age of he patient, is made downward from just in front of the tip of the internal mal- eolus, and everything, tendons, fascia, ligaments, nerves, and, if they are in the ray, vessels, divided down to the bone. Esmarch's bandage is used and the limb aised afterward, the wound being covered with protective and enveloped in ab- orbent dressings. In old cases, the neck of the astragalus is divided too.

As soon as the deformity is thoroughly corrected, the splints are left off dur- ng the daytime, and the feet exercised at least twice a day, the skin well rubbed, the muscles kneaded, and all the joints worked; but some appliance is required at night until the tendency to relapse has disappeared—until, that is to say, the shape of the bones is definitely changed. For infants, a light, tin splint is sufficient; it consists of a trough for the leg, a foot-piece at right angles with it and a little everted; a soft leather strap to keep the ankle down, and two webbing ones to maintain the position of the leg and foot respectively (Fig. 96). For older children the same appliance made of stouter metal, thin sheet-iron, for example, may be employed, or Little's (Fig. 97) or Scarpe's shoe. The latter is formed of a leather slipper with a leg-iron, and a well-padded, leather strap to fit round the calf. Opposite the ankle is a cog and ratchet arrange- ment in order to alter the angle as required, and attached to the outer side of the sole-plate is a metal spring, by which a certain degree of ever- sion can be secured. The foot is fixed in position first, the heel being held down by a strap passing over the front of the ankle, the calf-piece buckled, and then the sole-plate brought to the required angle with a key (Fig. 98).

FIG. 98.—Little's Modification of Scarpa's Shoe for Talipes.

In older children, especially in those cases which have either never been treated at all, or, what is nearly equally bad, have been allowed to relapse, a properly made boot with an outside iron and a calf-piece must be worn for a very con- siderable time after reduction, often for years, or the deformity is almost certain to return. If there is any inward rotation at the knee, the irons must be carried up the limb and fixed to a pelvic girdle (with a proper arrangement of joints) to prevent relapse effectually.

*Tarsectomy.*—An almost hopeless form of club-foot is occasionally met with in children and young adults. Tenotomy has been performed time after time without any permanent benefit; the bones are hopelessly distorted and peculiarly

hard, the ligaments shortened, the muscles wasted, and the limb comparatively useless. For such as these there is no alternative but amputation, giving them a stump to walk on (which is better than walking on the dorsum of the foot); (2) tarsectomy, removal of a portion of the tarsus, so that the sole may be brought down to the ground. Various forms of this operation have been devised, but the two that best answer the conditions are excision of the astragalus and the removal of a wedge-shaped portion of bone (taken chiefly from the cuboid and those on either side of it) from the outer border of the foot.

Excision of the astragalus is performed through a longitudinal incision on the outer side of the foot, between the tendons of the extensor longus digitorum and the peroneus tertius. The articulation between the scaphoid and astragalus is exposed, and the dorsal astragalo-scaphoid ligament (which may be much thickened) freely divided. The anterior end of the foot is then twisted so as to separate the astragalus from the surrounding bones, the anterior fasciculus of the external lateral ligament of the ankle joint cut through, and a stout, sharply-curved hook with a cutting edge on its concave surface passed between the os calcis and astragalus until it reaches the posterior extremity of the interosseous band. This must be cut through by steady traction, and then the astragalus is so nearly free that it may almost be tilted out of its socket by forced plantar flexion. The wound is treated in the ordinary manner, the foot being secured at once at right angles to the leg, with the sole in the proper position.

Excision of a wedge-shaped portion from the outer border of the foot is preferable if the varus is the more prominent. An incision, convex downward, is made along the outer border of the foot from the middle of the metatarsal bone of the little toe to the os calcis; the soft parts, tendons, arteries, etc., are carefully lifted off from the dorsal surface, and the peronei if possible pulled to one side. Then a wedge-shaped mass of bone, corresponding in size and shape to the deformity that is present, is removed with a chisel or with Adams' saw. The base of the wedge faces the upper and outer border of the foot; the apex points inward, while the sides slant down toward each other, so that the under (plantar) surface is much smaller than the upper. In actual practice the part removed is rarely so geometrical; roughly it corresponds to the cuboid with a varying amount of the neighboring bones; the essential point is that it should be of sufficient size to enable the foot to become straight and lie flat. Afterward the wound is thoroughly cleansed, drained if thought advisable, covered with an absorbent antiseptic dressing, and fixed with a plaster bandage. How long it should be left depends upon the patient's temperature and whether a drainage-tube has been used or not.

Fitzgerald, in old cases, divides all the tendons, including the tendo-Achillis and deep ligaments, down to the astragalo-scaphoid articulation. He then makes an incision on the outer side of the foot, from above downward, behind the calcaneo-cuboid articulation, passes a chisel in front of the ankle joint, down to the neck of the astragalus, divides this, the os calcis, and the scaphoid, and forcibly moulds and wrenches the foot into shape. A splint with a foot-piece is used to retain it in position afterward.

These operations undoubtedly enable the foot to be brought into a better position, and are infinitely preferable either to amputation or to progression upon the dorsum with the great toe projecting upward, a condition not uncommon among relapsed cases; but the necessity for them would not arise if they were properly attended to in infancy.

### Acquired Talipes.

Club-foot, apparently resembling the congenital variety, but in reality differing from it in many essential particulars, may be caused by infantile paralysis, spasmodic muscular contraction, fibroid degeneration of muscles consequent on inflammation or injury, and cicatrices following burns; or, again, it may be secondary, as when talipes equinus develops in hip disease owing to the shortening of the limb. Of these the most important and the most common is the first.

### 1. *Talipes due to Infantile Paralysis.*

In congenital club-foot the essential lesion is an arrest of development; the bones, ligaments, fasciæ, and muscles all take part in it. In talipes due to infantile paralysis the muscles alone are in fault at first, the bones are well developed, the fasciæ and the ligaments are not tense, the sole cause is the loss of power of one or more muscles or groups of muscles. Secondary changes, however, take place in this (unless means are taken to prevent them) just as they do in the congenital form. The opposing groups of muscles, having lost their antagonists, gradually become shortened and rigid; the bones from constant pressure become altered in shape, and even sometimes the ligaments contract (possibly owing to local inflammation, for as a rule they remain quite lax in other joints). The result is that, although the diagnosis between the two varieties is exceedingly easy, so long as the case is recent (in the one the foot can be placed at once in its natural position, in the other it cannot), it may become difficult in the later stages, unless there is a history of the deformity having been present at birth. Other symptoms of infantile paralysis render it, of course, practically definite; if the limb is cold and wasted,

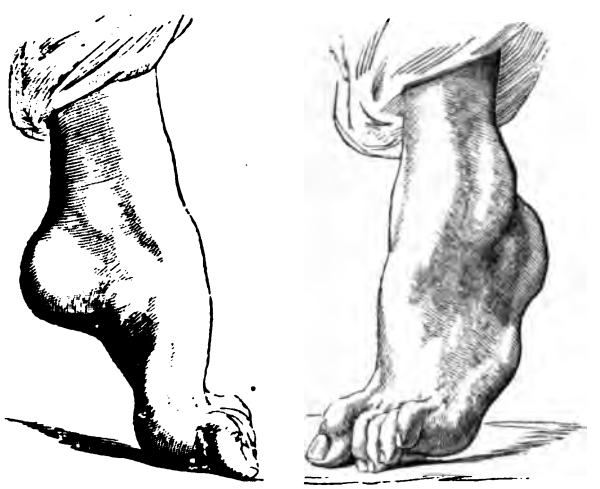


FIG. 99.—Talipes Equinus.

liable to chilblains, and smaller than the other in all its dimensions, the question may be regarded as settled; but the presence of one complaint cannot logically be regarded as conclusive proof of the absence of another.

*Varieties.*—These are the same as in the congenital form, but there are certain points of difference. Talipes equinus, for example, often occurs by itself; indeed, it is the most frequent of all, though mixed and irregular forms are not uncommon. Every grade is met with, from paralysis of all the muscles of the limb, with extreme distortion, to a loss of power that is scarcely perceptible and confined perhaps to a few fibres of a single muscle. As a rule it comes on about the second year, but it may not occur until much later; on the other hand, in cases of rickets, it may be present before the child begins to walk, so that the defect is often believed by the parents to have been present at birth (Fig. 99).

Talipes equinus results from paralysis of the extensors on the front of the leg. If all are involved equally the foot remains straight; if the tibialis anticus retains any power the inner side is raised and the sole looks inward.

In the worst form of infantile paralysis, when the loss of power is complete, the whole foot dr[illegible] the heel becomes almost vertical, and the astragalus

rolls forward from under the tibia until the dorsum drags along the ground. T whole extremity is atrophied and cold, the bones fail to grow, the skin is consta liable to chilblains, and chronic ulcers make their appearance every winter. If gastrocnemius escapes the heel is dragged up and after a time becomes fixed, usually a certain degree of varus, owing to the natural tendency of the foot to sume that position when at rest. Nearly always, however, when the mischief i extensive as to involve all the muscles on the front, the gastrocnemius and the d flexors suffer too, not, perhaps, so severely, and the paralysis being general, f displacement does not follow.

In those not quite so bad when the loss of power in the anterior muscle only partial, the chief displacement usually occurs at the mid-tarsal joint, the an itself being less affected. The scaphoid and cuboid are drawn downward a backward, and the head of the astragalus is left projecting on the dorsum alm uncovered. After a time this becomes permanent, the ligaments and fascia on plantar surface shortening and growing rigid. In some instances the sole of foot is so much contracted that the anterior half is almost if not quite at ri angles with the posterior, the heel is raised completely off the ground, and t weight borne on the ends of the metatarsal bones. In others, probably when th interossei and the short flexors of the great an little toes are involved, this is associated with a peculiar claw-like condition of the foot, the proximal phalanx being over-extended, the distal ones flexed.

FIG. 100.—Talipes Calcaneus.

In the milder forms when the paralysis is temporary only (as after diphtheria) the distortion is very slight; the heel is merely a little raised, and the sole of the foot a little shortened (*talipes arcuatus*); but if it continues long enough for contraction of the fascia to take place (*talipes plantaris*) it may prove the source of great inconvenience; the gait is awkward, there is great pain on standing, corns form beneath the metatarsals, reflex muscular spasm is not uncommon, and active exercise is very difficult. The diagnosis can be made at once by comparing the impression left after standing with that of the opposite foot; the arch is shorter, very much less of the sole comes into contact with the ground, and the outer part of the tread in particular is narrowed. In long-standing cases the contracted bands can be felt standing out on the inner side of the sole.

Analogous deformities are caused by paralysis of other groups. Talipes calcaneus is due to loss of power over the muscles of the calf (Fig. 100); valgus is said to occur when the tibials are affected, and compound forms if more than one group is weakened. Very often these are rendered still more complicated by secondary displacements caused by attempts at progression. Thus inversion and rotation may occur to such an extent in talipes equinus that a condition closely similar to true varus is produced, the foot being displaced laterally to compensate for the want of flexion. In other instances valgus follows, but as a rule these additional deformities can be recognized as such by examining the foot when lifted from the ground; as soon as the weight of the body is taken off it drops of itself into the straight line.

**Treatment.**—This is entirely different from that of congenital talipes, and depends upon the grade of paralysis and the extent to which deformity has taken place already. [In all cases, however, it is essential that the foot be kept in position continuously, by an appropriate appliance.]

the simplest form of talipes equinus, where the arch of the foot is exaggerated, the tread narrowed, and standing painful, relief may be obtained almost at once by dividing the contracted bands in the plantar fascia. In all cases, however, of paralytic talipes it is advisable to exercise great discretion in the manner of tenotomy, or the already weakened limb may become still worse.

[The rule is that when the foot can be restored to position by the hand easily, the patient being under an anæsthetic, operative measures are useless, for there is no actual contracture of the soft structures.]

### 2. *Talipes due to Muscular Rigidity.*

What is known as "spastic rigidity" of the muscles of the lower limb (and occasionally of the whole body) is sometimes present at or shortly after birth, connected, in all probability, either with defective development of the nerve-centres, or with injury sustained during parturition; but the deformities to which it gives rise are rarely limited to the feet; and even when they are, they present but a remote resemblance to ordinary talipes.

Tonic shortening of the gastrocnemius (the so-called right-angled contraction of the tendo-Achillis) is not infrequent as a consequence of prolonged confinement with the foot pointing forward, whether it is due to a badly set fracture or to the pressure of the bedclothes in the course of some exhausting illness, such as typhoid fever. It can be recognized at once by pressing the knee well back while the leg is extended; and though it does not appear serious, it causes a very considerable degree of lameness in walking, and not infrequently ends in grave deformity. The movement that cannot take place at one joint must take place at another; and the arch of the foot gradually gives way until a condition closely resembling ordinary flat-foot is produced; the head of the astragalus and the scaphoid sink together, and in some extreme cases the inner border of the foot becomes convex. Sometimes, on the other hand, especially in those instances in which no attempt at walking is made, the foot is twisted into a shape resembling varus, the natural position it assumes when at rest; but it rarely happens that this is permanent unless there is at the same time paralysis of the extensors.

In every case of fracture the foot should be carefully kept at a right angle throughout; if the toes are allowed to point, serious disablement may be produced before it is noticed; and attention should be paid to this in cases of exhausting illness; the bedclothes should not be allowed constantly to weigh the feet down. If it is present already it can usually be cured by massage, passive motion, and the use of an extending rubber band; but occasionally tenotomy is required.

## Flat-Foot.

The antero-posterior arch of the foot is maintained partly by ligaments, partly by muscles; the former are the inferior and external calcaneo-scaphoid and the anterior fasciculus of the internal lateral of the ankle joint; the latter, the tibialis anticus, the flexors of the toes, and especially the peroneus longus, which passes like a strap across it and prevents the anterior pillar slipping forward when the weight of the body rests upon it.

**Cause.**—Neither ligaments nor muscles are capable of maintaining the arch of the foot by themselves; the combination is essential. Some of the worst cases of flat-foot follow Pott's fracture when the internal lateral ligament of the ankle joint is torn, while, on the other hand, it is often the result of loss of power in some of the muscles; the rest become tired out, and the ligaments which are not calculated to stand a persistent strain yield and give way under the weight.

Independently of accidents, it may occur in infancy, at puberty, or in adult life. At birth the arch has hardly any existence; it only becomes perfect, like the curves of the spine, when the muscular system becomes active, and if from rickets or any other cause in early childhood the time at which this takes place is

much delayed, the development of the arch is seriously impaired. It is probable that in this matter rickets is of unusual importance; although the change is not so obvious there can be little doubt that the osseous nuclei in the tarsus are affected in the same way as those elsewhere, and that the shape of the bones, especially when the rickety period is prolonged, may be permanently altered, rendering subsequent development imperfect. It is not uncommon to find every single member of a family flat-footed from early childhood.

The form of flat-foot that occurs at puberty is still more common, and is nearly always associated with genu valgum and lateral curvature of the spine. The causes of the three deformities are the same, and naturally they usually occur together. The strength of the bones and ligaments is dependent upon the perfection of muscular development; at puberty, if growth is rapid, the weight of the body becomes too great for its strength, the muscles give way, the strain falls upon the ligaments, which are already weak and lax, and deformity follows, either in the feet, the knees, or the spine, or in all three together. At first the bones are unaffected, but in a very little while they become altered in shape, and then, short of operation, the condition is permanent. When the food is poor, the hours of labor long, and the patient kept standing without a rest the whole time, deformity is exceedingly rapid.

In adults, flat-foot rarely occurs except as a result of accident (Pott's fracture), of rheumatism (gonorrhœal or not), or of some illness that seriously affects the strength of the muscles, such as diphtheria or typhoid fever. I have known it result from a violent blow on the upper part of the fibula injuring the peronei, either directly or through their nerve supply.

**Symptoms.**—The alteration in shape is characteristic. The astragalus slowly sinks forward, slipping, as it were, off the sustentaculum, which sinks with it; the scaphoid is displaced, or even partially dislocated, the axis of the os calcis is no longer directed upward, the inner side of the foot is lengthened, and when the patient rests his weight upon it the whole of it touches the ground. In the worst cases the outer edge is a little raised and everted, and the peronei tendons stand out like rigid cords.

In the rheumatic and gonorrhœal forms the pain is intense; in the ordinary one that occurs at puberty, the foot is perfectly easy of a morning; the muscles are rested then and can do their work. By-and-by, however, they become tired, the strain falls upon the ligaments, and the pain as they stretch grows more and more severe. It ceases at once if the foot is raised from the ground. Sometimes in these cases, when the strain is kept up continuously, there is a considerable degree of inflammation, and the astragalus and scaphoid may even become ankylosed. More often the arch sinks completely down, and then the pain subsides; the weight is borne by the bones directly, and there is no more stretching.

In many instances the foot is perfectly flat, even when there is no weight resting upon it; in doubtful cases it is advisable to let the patient stand for a moment, with his feet just wetted, upon a sheet of colored blotting paper; the surface that comes into contact with the ground when his weight bears upon the arch can be seen at a glance.

**Treatment.**—In the early stages of the deformity, while the arch still persists, much may be done by means of massage, cold sponging, and tiptoe exercises. The nutrition of the muscles improves, and if long standing and fatigue are avoided, the cure is often permanent. The heel of the boot should in all cases be deeper upon the inner side than the outer, as recommended by Thomas, of Liverpool.

If the arch is already lowered, and the patient's occupation cannot be changed, cure is practically hopeless; the cause continues and the effect will grow worse. Relief, however, may be obtained by wearing properly contrived supports. In the slighter cases, a valgus pad made of rubber, or, if this is too hard, of leather stuffed with horse hair, may be fixed inside the boot. The heel should be broad and low, the waist fairly rigid, and ample space allowed in front. The pressure

must, it is true, act to a certain extent injuriously upon the tissues in the c cavity, but it is a choice between two evils.

FIG. 102.—Walsham's Shoe.

In worse cases, when the foot remains even though no weight is resting upon it, thi not enough; however well made the boot, the is sure to rotate in it, and the only way to mak secure is by means of an outside iron. The lo end of this is let into the heel; opposite the an it is jointed, and above it is fastened by a b round the calf. A triangular piece of leather sewn inside the boot, on its outer border, so t it passes under the sole of the foot, beneath t astragalo-scaphoid articulation, up the inner sid through a slit in the uppers, and is buckled to th iron. Or a rubber band is used in the same way after Walsham's plan (Fig. 102). For a time at least this gives relief; and if tiptoe exercise is diligently practiced, after some months there may be distinct improvement.

When the pain is very great, and the peroneal tendons are tense, this cannot be carried out at first. The foot must be rested and raised, until the tenderness has subsided; then the patient is placed under an anæsthetic, all the joints worked and wrenched to their full extent, and the foot brought into the best possible position by forced inversion, combined with direct pressure upon the scaphoid. This position is maintained for a week or ten days by means of a plaster bandage, and then the process is repeated until something like an arch is restored. The peronei tendons should not be divided if it can possibly be avoided.

In some of those that are worse still tarsectomy and other similar operations are recommended. The head of the astragalus has been excised (Stokes) and the foot forcibly adducted. The astragalo-scaphoid articulation has been opened freely, sufficient bone removed to enable the arch to be restored, and the two bones drilled and fixed with a couple of ivory pegs passed through them (Ogston); and the scaphoid has been excised by others. It is possible that in some cases in which there is persistent pain these operations may be of some use; they undoubtedly restore the shape of the arch, although it is probable that bony ankylosis always occurs (in Ogston's this is partly the object); but seeing that they can only be recommended for extreme cases, and that these have for the most part already passed the painful stage, the number for which they are advisable is very small. When the arch has once become flat, so that the inner border of the foot rests upon the ground, the gait is very ungainly, it is true, but the inconvenience is rarely sufficient to recommend an operation which practically must lay the patient up for many months. [And even after the operation the shoe will, nevertheless, have to be worn for a long period, so that the operation is obviously of extremely doubtful utility.]

## DEFORMITIES OF THE TOES.

### *Hammer-Toe.*

This name has been given to a peculiar deformity which affects the second toe in particular, but sometimes all. The first phalanx is retracted at the metatarso-phalangeal articulation, the second is flexed at right angles to the first, and the third bent so that its true extremity is directed downward. In the earli stages of the disease the parts can be placed in the normal position without culty, but after a little while the ligaments contract and the displaceme

nent, the first phalangeal joint becoming rigid, as a rule, before the metatarso-phalangeal one.

The cause of this deformity is unknown in most cases. It is not unfrequently congenital and even hereditary; usually it is symmetrical and often confined to the second toe. It may be associated with the slighter forms of talipes equinus (talipes arcuatus and plantaris) and caused by contraction of the plantar fascia; or the rest of the foot may be absolutely normal. That it can be produced by wasting of the interossei there is no doubt, as it is not unfrequently seen in cases of progressive muscular atrophy; these muscles flex the metatarso-phalangeal articulation and extend the other two, and when they alone are paralyzed the various segments naturally assume the opposite position. In the vast majority of instances, however, no evidence of paralysis is present. The lower part of the lateral ligaments of the first phalangeal joint is always much shortened and contracted, and it has been suggested that the deformity is due to chronic inflammation beginning in this articulation; but it is equally possible that the change is a secondary one, caused by permanent fixation in an unnatural position. The changes in the other structures of the joint, no doubt, are secondary. Whether it can be caused by ill-fitting boots is equally uncertain; it is probable they aggravate the deformity, but as it is occasionally present at birth (though it more frequently develops at puberty), and as it is not more common in one class of life than another, hospital patients suffering as frequently as those in a better station, the influence they possess is doubtful.

**Treatment.**—In the slighter cases, in which contraction has not yet taken place, relief may be obtained by wearing suitable boots, sufficiently broad in front, with low heels, and by massage and friction. If this does not succeed, an attempt may be made to keep the toes extended by means of a metal sole-plate, worn at night, and as long during the day as practicable. The portion that comes under the toes is provided with slits through which little elastic and leather bands are passed, so as to draw the toes down; or the plate may be double, one part above the foot and the other below, with little screws and pads, so that direct pressure can be exerted upon the joints from above.

In most cases, however, the time for such simple remedies as this is already past. The contraction of the ligaments and fascia is too rigid to admit of gradual extension, and the toes are distorted and deformed with callosities. The choice then lies between division of the lateral ligaments, excision of the proximal end of the offending phalanx, and amputation. Of these the second is the only one that holds out a definite prospect of relief without risk of relapse and without the mutilation involved in amputation. Subcutaneous section of the lateral ligaments, however, is such a simple proceeding and lays the patient up for such a short time that it may reasonably be tried first.

### *Deformities of the Great Toe.*

(*a*) ***Hallux Flexus.***—This deformity, described by Davis-Colley, closely resembles hammer-toe in many respects. It occurs under the same conditions; it is apparently not, like hallux rigidus, dependent upon flat-foot, and it usually develops at puberty; but the metatarso-phalangeal joint is flexed instead of being over-extended, and the toe is wholly bent downward, so that the patient is compelled to walk upon the outer side of the foot. The suggestion that the difference is to be accounted for by the different development of the great toe, the metatarso-phalangeal joint corresponding to the interphalangeal of the others, is attractive, but probably not correct, as true hammer-toe is sometimes met with.

(*b*) ***Hallux Rigidus.***—This name has been given to a peculiar stiff and painful condition of the metatarso-phalangeal articulation. Considerable doubt exists as to whether it is not identical with the former (although the toe is kept in a straight line with the foot); it differs, however, in being nearly always associated with flat-foot, and probably dependent upon it, inflammation of the joint being caused by

repeated slight injury from ill-fitting boots. A similar condition is sometimes pr duced by osteoarthritis.

It is usually met with at puberty and in boys who have to stand for many ho together. In the early stages there is often a certain amount of inflammation, b it is rarely very marked or prolonged. Nearly always the toe is cold, stiff, an rigidly extended, sometimes quite straight, sometimes with a certain degree o valgus. The least attempt at flexion causes severe pain, and in all but the slightes cases there is distinct enlargement with lipping and hypertrophy of the articula ends. The nature of the deformity can often be detected at once by noticing th condition of the boot; the arch is flat; there is a projection in front where th toe presses against it, and there are no wrinkles in the leather, showing that th joint is never used.

The treatment of this affection, like that of hallux flexus and hallux valgus, is very unsatisfactory. If seen in time, it may be cured by restoration of the arch of the foot, but nearly always extensive changes have made their appearance in the articular surfaces before the patient is aware of the extent of the mischief. The question then turns upon the amount of pain; if it is only slight a well-made, roomy boot, with a valgus-pad, may answer; but if it is more severe, particularly if it prevents the patient taking a fair amount of exercise, the best plan of treatment is to remove a sufficient portion from the proximal end of the first phalanx. The same thing must be done for hallux flexus.

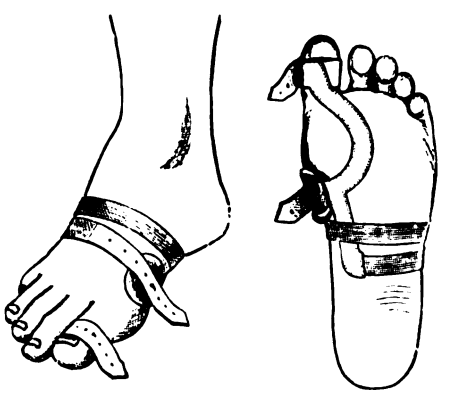


FIG. 103.—Lever for Relief of Hallux Valgus.

(*c*) *Hallux Valgus.*—The deformity affects the same joint, but the toe is bent outward, either over or under the others, until it may be at right angles to its normal direction. This, there is no doubt, is always due to ill-fitting boots. The articular changes in the early stages are the same as in hallux rigidus and in other forms of chronic traumatic arthritis; but after a time gouty or rheumatic inflammation usually follows, and urate of soda is deposited, or immense lips of bone are formed and the surface becomes hard and polished from friction.

Hallux valgus derives much of its importance from its association with bunion a bursa developed over the inner side of the joint from the constant pressure and friction of the boot. This may be found in all stages of inflammation; when it is recent there is merely a thin-walled sac, filled with clear fluid; after repeated attacks it becomes thick and fibrous, until, with the corn that lies upon it, it forms an almost solid swelling; or else it suppurates, and then it becomes serious, from the fact that it nearly always communicates with the joint. In most cases, however, by this time the cartilages have disappeared and there is nothing left but two hard, bony surfaces, held together by a tough, fibrous capsule.

The treatment in the earlier stages is very simple; the boot must be made the shape of the foot—straight, that is to say, upon the inner side; and at night, and whenever it is convenient, a sole-plate must be worn with a spring upon its inner border to draw the toe into line again. If matters have gone too far for this, all that can be done is to prevent further injury. Should suppuration occur in connection with the joint, a free opening must be made upon the inner side, and a sufficient portion of the base of the first phalanx removed to bring the toe into the right line again. The metatarsal itself is better left untouched, but a fair amount of bone must be taken away or osseous ankylosis will ensue. Osteotomy of the neck of the first metatarsal is recommended

for simple hallux valgus, bringing the toe into line at once, and as it can be done almost subcutaneously is not a serious operation; but it rarely happens that patients consider the deformity alone a sufficient reason, as it seldom causes much discomfort until a bunion is developed.

## Genu Valgum.

Knock-knee, like the other deformities due to want of strength, may occur either in childhood or at puberty. In the former case it is always associated with rickets; in the latter it is usually met with in conjunction with flat-foot and lateral curvature of the spine. Owing to the width of the pelvis the natural direction of the femur is from above obliquely downward and inward, and this determines the direction of the deformity; the disproportion between the weight to be carried and the strength of the muscles (upon which the perfection of the ligaments and bones depends) regulates the amount; and when it once has commenced it naturally advances at a much more rapid rate.

The nature of the deformity is obvious at once, but the extent requires careful measurement. The lower margin of the internal condyle is prolonged downward far below the level of the external; but it does not project in the least backward. Consequently the legs are perfectly parallel when the knees are bent, and diverge only when they are extended. The essential change is an overgrowth of the inner border of the diaphysis, although the internal condyle may be itself somewhat elongated.

That it is solely due to obliquity of pressure and consecutive alteration in the shape of the bone is shown by the similar distortion that occurs when one thigh has been amputated in a child and no artificial limb has been worn. From constantly bringing the remaining leg under the centre of gravity of the body, so that the crutches may be swung forward, it assumes a condition of extreme genu valgum, the inner condyle being prolonged downward and not backward in precisely the same manner. The two worst cases I have ever seen were caused by this; the method of production is identical with that of the ordinary form which develops at puberty; the cause is somewhat different.

**Treatment.**—This depends upon the degree of deformity and the length of time it has lasted. In any case a certain amount of rest is the first consideration; the cause, as in lateral curvature, is excessive work; the strength is not equal to the weight, and so long as the weight is allowed to press upon the knees and drive them inward the deformity must grow worse.

(*a*) In children in whom there is other evidence of rickets the prognosis is good unless the hardening stage has set in, and buttresses of compact tissue have been deposited in the concavities of all the bones; if this has occurred the condition is permanent, short of operation. Cod-liver oil, iron, good food, meat, eggs, and milk are essential. In the slighter cases it is impossible to confine the child to bed, but it should never be allowed to tire itself; the nutrition of the legs and of the muscles in particular must be maintained by rubbing with oil night and morning, bathing with salt water, friction, massage, warmth, and galvanism. If this is thoroughly carried out the limbs gradually become straight of themselves.

If the condition is more serious—that is to say, if there is a definite interval of some inches between the malleoli when the knees are extended—the same plan must be pursued; the child must be kept in bed and splints applied every day, to draw the knees slightly outward. Too much pressure should not be used; the skin is exceedingly delicate and sores are easily formed; but, on the other hand, unless the parts are well fixed, children can always twist their legs round until by slightly flexing the knees they escape pressure altogether. Where trouble is no object the splints should be removed night and morning, an inside one being worn at night, an outside one in the daytime; and every time they are changed the skin should be thoroughly rubbed, the muscles kneaded, and the part manipulated into the right direction with as much force as is consistent with avoiding pain.

An extraordinary degree of improvement can be effected in this way in a very short space of time. The muscles gain size and strength; the tone of the limb improves; the legs grow straighter and the inequality between the condyles disappears. I have more than once seen a leg become perfectly straight while a child was lying in bed recovering from an osteotomy performed upon the other one. It is, however, of little or no good after sclerosis has set in.

(*b*) The form of knock-knee that develops at puberty must be treated on the same principles. It is nearly always met with in those whose occupations compel them, just at the time they are growing most, to stand many hours a day; and it is nearly always associated with flat feet. Of course, if the occupation is continued very little can be done; the deformity will grow worse until a kind of equilibrium is reached; but if this can be changed, and the tendency to flat-foot checked either by a valgus-pad or by Thomas's obliquely-cut heel, the limbs can generally be brought into the right line.

In worse cases, in which the period of growth is ended, or in which the deformity when the knees are extended is considerable, osteotomy affords the better promise. At this age it is not possible to effect any considerable change in the shape of the bones, as it is in children and especially in rickety children. If pressure is persisted in, the fibrous structures on the outer side of the joint, the external lateral ligaments, and the ilio-tibial band are very likely to yield, and allow the external condyle to separate itself from the tibia, so that when the splints are removed and the patient is allowed to stand upright, he is merely propped upon the internal condyle in a most insecure manner.

## Rickets.

In rickets many deformities of bones are met with besides genu valgum. The femur is often bowed outward and forward; the tibia is bent, especially at its lower extremity where, it is weakest, until the convexity of the curve seems to hang over the ankle; and in other cases again the femur and tibia together are curved outward, so that exactly the opposite condition to genu valgum is produced—bow-leg, or genu extrorsum. The particular kind of deformity is regulated partly by the natural curve of the bones, partly by the attitude and habits of the child, whether it is old enough to run about, or sits tailor-wise upon the ground. In some rare instances genu valgum on one side is associated with the opposite deflection upon the other, but this is more usually a product of later life, caused by accidental deformity.

The treatment is the same as that for genu valgum. If the bones are still soft and the weight is taken off them, and if the strength of the child and the condition of its muscles can be sufficiently improved, the deformity disappears of itself. Splints are of no use in the majority of cases; the antero-posterior curvature of the tibia, for example, does not admit of pressure being applied; and it is questionable whether the fashion of fastening them on so that they project below the feet and prevent walking does not do more harm than good; for not unfrequently the child learns to shuffle about with its limbs in a worse position than they were before.

If the rickety stage is passed, and deformity is left, it can only be rectified by osteotomy.

**Osteotomy.**—Section of a bone for reduction of deformity, or osteotomy, is performed either with a chisel or a saw. The former, as a rule, is preferable, not so much because of the dust caused by the teeth, as because of the almost unavoidable laceration of the soft parts; and MacEwen's chisels, made of solid metal throughout and graduated, are the best. If a saw is used, no instrument has superseded that devised by Adams for subcutaneous section of the neck of the femur.

The operation is subcutaneous so far as it is possible to make it. The limb is thoroughly cleansed and embedded firmly on a sand-bag covered over with a rubber sheet. A small incision, parallel to the most important structures, is made

[illegible]n to the bone at the spot at which it is intended to divide it, and the chisel or [illegible] passed down by the side of it before it is withdrawn. If a chisel is used, care [illegible]st be taken always to work away from important structures; with a little prac-[illegible]ce, the different sensation as it passes from compact to cancellous bone or *vice versa* can be appreciated at once; but there is no object in running any risk. MacEwen recommends that the surgeon should always cut toward instead of from himself, and that, if the structure to be divided is very wide, and the chisel deeply buried, a narrower one should be substituted for it as soon as the first incision is made; it is impossible to form a correct impression if the instrument is fixed, like a wedge, by the sides of the cut. The chisel must be held in a firm grasp, and should be loosened in its bed from time to time as required by an upward and downward movement, not a transverse one, for fear of splintering.

The general rule is to divide the compact tissue opposite the point of entrance of the chisel first; then (if it is working from the side) that on the upper and under surface of the bone; and finally the soft central portion, leaving in this way the part on the furthest side uncut. If the bone is very wide the last part may be effected with a narrower chisel, which will produce something of the effect of a wedge-shaped wound. As soon as the division is considered sufficiently complete, the chisel is withdrawn from the bone with an upward and downward movement, gradually loosening it, a sponge placed over the wound, and the remaining part of the compact shell fractured. Some iodoform is then dusted over the surface; a catgut suture inserted if necessary; then an absorbent dressing, and a suitable splint, taking care to move the limb as little as possible while it is being applied.

**Operations for Genu Valgum.**—Many operations have been devised for the correction of this deformity; but except in special cases, MacEwen's is the one that is usually practiced. It consists in subcutaneous section of the lower end of the femur, immediately above the condyles, with a special chisel.

The cutaneous incision commences at the junction of a line drawn transversely a finger's breadth above the external condyle with a longitudinal one half-an-inch in front of the tendon of the adductor magnus. The scalpel is carried down to the bone and the incision prolonged sufficiently to admit the osteotome. This (beginning with the largest) is introduced by the side of the scalpel before it is withdrawn, and then turned round through a right angle. The posterior internal border is the part first divided, the chisel pointing forward and outward; then the internal border; and after that toward the outer posterior angle, working always from the artery. After the compact layer is cut through it is advisable to change the osteotome for one with a narrower blade, especially in the case of an adult. Then the residue of the bone is fractured, the limb brought into a straight line, and a suitable splint applied. In children, the most convenient apparatus is one of the ornamental flower-pot holders made of diagonal bars; it can be placed in position at once; and it is sufficiently flexible to fit accurately over the dressing. If the little wound is sealed with iodoform-collodion and covered with wood-wool, there is no need to disturb it until the fracture is sound.

In Ogston's operation the internal condyle of the femur is detached and pushed further up the shaft. It may be performed either with a chisel or a saw. A long-bladed tenotomy knife is introduced two or three inches above the internal condyle and pushed through the tissues until it can be felt in the inter-condyloid space; the soft structures are then divided down to the bone, Adams' saw passed by its side, and the tenotome withdrawn. The internal condyle is sawn about three-quarters through from above downward, and the fracture completed by forcibly straightening the limb. The same precautions and the same after-treatment are required as before.

Reeves, who uses round-edged chisels without angles, modifies this by dividing the bone only and leaving the cartilage to be ruptured.

*Redressement* (forcible straightening) was practiced largely at one time, but though the limb can often be brought into a straight line, it is impossible to

say what yields; it may be the epiphysial line, or the lower end of the shaft, or t ligaments.

Whatever form of operation is used, the limb requires support for ma months. It must not be forgotten that, though the deformity is cured, the cau that gave rise to it are probably there still, and that, unless precautions are take it will infallibly return.

Rickety deformities of bones are treated on the same principles. Subcuta neous fracture (either manual or with an osteoclast) succeeds sometimes, the bo breaking (or if it is still soft, bending) at the weakest spot, and enabling the li

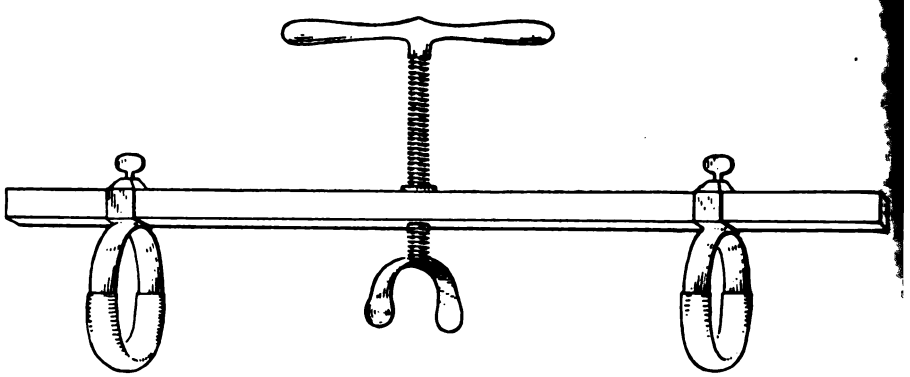


FIG. 104.—The Osteoclast of Rizzoli.

to be brought straight at once. In most cases, however, osteotomy is preferred, either simple linear division, or, if the deformity is very great, cuneiform—that is to say, the excision of a wedge.

[**Osteoclasis.**—This consists in fracturing the bone with the osteoclast invented by Rizzoli, and in special cases it is preferable to osteotomy; the difference in the respective wounds being that between a simple fracture and an open (compound) one, except that in osteotomy there is a clean-cut incision instead of an irregular or serrated break. Repair is apparently more speedy after osteoclasis.]

## SECTION II.—INJURIES OF BONES.

### FRACTURES.

A fracture is a sudden interruption in the continuity of a bone, produced by violence. For convenience of description, this definition is allowed to include other injuries similar in character, such as separation of the costal cartilages from the ribs, and in young subjects separation of epiphyses.

Fractures are divided into two classes, *simple* and *compound.** In the former the skin is unbroken, the fragments are never exposed to the air, there is no risk of absorption, and the injury is repaired like a wound that heals by the first intention; in the latter, the broken ends are laid bare at some time or other, a way is opened up for the absorption of foreign substances, and there is (so long as the wound is open) the constant danger of cellulitis, necrosis, phlebitis, pyæmia, and other infectious diseases.

A fracture may be compound at the time of the accident, or may become so at a later period from sloughing of the skin and soft tissues over the broken ends. When it is compound from the first, either the wound and the fracture are produced together by the same force—a cart-wheel, for example, passing over a limb and tearing the skin from off the bone as it crushes it; or the pointed end of one of the fragments is driven from underneath through the skin, owing to involuntary muscular contraction at the time of the accident, or want of care in handling the part afterward. In the former case (*compound by direct violence*), the injury to the soft parts is generally extensive; they are bruised and crushed for a considerable distance on either side; in the latter (*compound by indirect violence*) there is only a puncture, the wound may close at once, and the fracture become, to all intents and purposes, a simple one.

The danger is less when the fracture becomes compound secondarily from sloughing or other causes. Absorption from the surface is not so easy; the gaping channels that are present in a recent wound are sealed by the lymph already thrown out, and the current sets rather from the deeper parts outward, so that, provided the sloughing is local and limited, the risk of septic poisoning is not so immediate.

Fractures, simple or compound, are said to be *complicated* when the viscera or other important structures near are involved; when, for instance, the ribs are driven into the lungs or liver, or when a large artery is punctured or torn across.

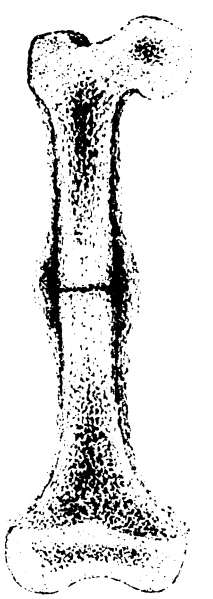


FIG. 105.—Transverse Sub-Periosteal Fracture of Femur, with Beginning of Callus. From an Infant.

Fractures are *complete*, if the bone is broken entirely through; *incomplete*, if the injury falls short of this in any way; and *sub periosteal*, if, as often happens in children, the tough periosteum remains untorn (Fig. 105).

The cancellous tissue of a bone, for example, may be crushed and compressed, or a splinter may be chipped off from the side; or the compact tissue may be fissured in one or more directions, without any fragment being actually detached. A peculiar form is common in children, affecting the long bones, especially the clavicle. The osseous tissue in them is so soft and elastic that it can bend, in some

[* The term, "compound," so long applied to these fractures, is a meaningless one; the German term, *open* fracture, is much more expressive.]

cases almost to a right angle, without breaking, and regain its shape completely soon as the pressure is removed. Generally, however, before this point is reach longitudinal fissures make their appearance in the bones, and then, if the fo continues, the periosteum and the compact tissue at the apex of the curve be to tear, until the fracture extends perhaps half across. These are called *gre stick* fractures, as the bone is not actually broken in two; they do not regain th shape when the force is spent, and often, owing to the jagged nature of the e and the way they fit against each other, there is considerable difficulty in straighte ing them again (Fig. 106).

A fracture is *single* when the bone is broken in only one place, *multiple* when it gives way in more than one, and *comminuted* when there is a number of small fragments at one spot. It may

FIG. 106.—Greenstick Fracture of Radius, Showing the Longitudinal Splintering. In this case it ran down to the epiphysis, which has been separated by maceration.

FIG. 107.—Comminuted Fracture of Clavicle.

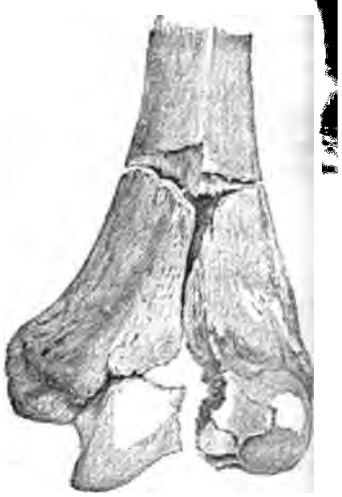


FIG. 108.—T-shaped Fracture of Lower End of Humerus.

vary in direction as well as in extent, and be *transverse*, *oblique*, or *longitudinal*. Sometimes, as in the patella, it is *stellate*; sometimes *serrated*, like the teeth of a saw; or it may run round a long bone in the form of a spiral. It is *T-shaped* when there is a transverse fracture immediately above a joint and the smaller of the fragments is split vertically into two (Fig. 108); *punctured*, when there is a wound in the substance of the bones; and *perforated*, when it goes right through. Finally, if one fragment is driven into the substance of the other—if, for example, the compact wall of the shaft is driven into the soft, cancellous tissue of one of the articular ends, so that the two are locked together, it is said to be *impacted*.

*Influence of Age.*—Fractures are met with in all periods of life, but with very different degrees of frequency at different ages.

*Intra-uterine fractures* are not uncommon. They may be caused by muscular contraction of the walls; but in most cases they can be traced directly to severe fall or a violent blow upon the abdomen during pregnancy. The lon bones, especially those of the leg, suffer most frequently, the skull from its pr tected position and its elasticity generally escaping; sometimes they are compou and a scar is found upon the skin corresponding to the point at which it was pe forated by the bone. The degree of union depends upon the time; as a rule, is fairly firm, though the position may be faulty. Multiple fractures (and in so instances an enormous number has been recorded) rarely occur, except in the c of intra-uterine disease, possibly hereditary syphilis.

It is noteworthy that in quite half the cases in which the leg is found birth to be bent at an angle, as if it had been broken, and even when there is appearance of a cicatrix at the point, the fibula and the toes on the outer side the foot are deficient. Talipes is often present at the same time; the limb is i perfectly grown, and frequently remains more or less stunted throughout life.

In infancy, the clavicle and the femur are the bones that suffer most frently, and the fractures are often greenstick or sub-periosteal. Separation of e epiphyses is common in childhood, but may be met with up to one or two and enty years of age. In adult life, much depends upon the sex and occupation. he bones are harder and more dense than they are at earlier periods. Fissured actures occur more easily, and, as a consequence, the joints are more often involved. Old age is specially characterized by two varieties, fracture of the neck of the femur and (particularly in women) fracture of the lower end of the radius from falls upon the hand.

## CAUSES.

The causes of fractures are predisposing and immediate. The former include all those conditions which render the bone more fragile; the latter, the actual breaking force. If this is unusually slight, so that the bone gives way without (apparently) sufficient reason, the fracture is said to be spontaneous.

### 1. *Predisposing Causes*

These may involve the whole length of a bone (and even the whole skeleton) or may be local, affecting the structure and impairing the strength at one part only.

(*a*) ***General.—Simple atrophy*** is the most common. When a limb is kept at rest for any length of time—rigidly confined in splints, for example, owing to disease of some neighbouring joint—the bones gradually waste away, the cancellous tissue becomes more and more open, the medullary canal enlarges, and the compact layer is absorbed from the interior, until, in extreme cases, a thin shell of solid substance is all that is left. It is in a certain measure owing to this, that if a bone once broken gives way a second time before repair is complete, it nearly always yields—not at, but close to, the seat of the original injury. Atrophy is also said sometimes to follow injury to the nutrient artery.

***In old age*** the bones are affected in a similar way, and in addition the proportion of lime-salts to the organic basis appears to increase, so that they become more brittle. This cannot, however, be called pathological unless the change reaches an extreme degree, so that an unusually slight amount of violence is sufficient to make them give way.

***Infantile paralysis***, owing to the feeble nutrition of the limb, leads to the same result. The bones never attain their full development; they remain slender and feeble; the surface is smooth, without any muscular ridges to act as supports, and they are deficient in weight and strength.

Fractures are very prone to occur in certain *affections of the nervous system*. The nutrition of the bone suffers whether the limbs are kept at rest or not; there is no tendency to inflammation, but two-thirds of the inorganic material (especially the phosphate of lime) may disappear; the cortex becomes exceedingly thin, and the medulla replaced by fat, until in some cases the bony substance is so soft that it can be cut with a knife. This has been noticed particularly in locomotor ataxy, affecting chiefly the lower limbs, and appearing even before the incoördination; in general paralysis, where the ribs seem to suffer most, and also in some cases of dilatation of the central canal of the spinal cord. It is singular that if the bones do give way under these conditions, union often takes place easily and with an exceptionally large amount of callus.

***Rickets*** is another common cause. The intermediate layer of cartilage becomes abnormally thick; instead of there being merely a line of soft tissue ready to be replaced by bone, it may form a broad band of gelatinous material, in some cases nearly as thick as the cartilage of the epiphysis itself. The deeper layer of the periosteum is affected in the same way; and, as the process of absorption from the interior continues with unabated vigor, the strength of the bone at last becomes impaired to such an extent that it is unable to bear any strain. Owing to the thin-

ness of the compact tissue in comparison with the thick layer of soft material on the outside, subperiosteal and partial or greenstick fractures are very common, especially at those places where the bones are naturally curved. So long as the rickets is actively progressing, the amount of callus is only small; afterward, it is thrown out in great excess, particularly on the concave side.

In *osteomalacia* the bones, if they are exposed to any force, do not break so much as double upon themselves and bend. The compact tissue is softened and disappears; the Haversian spaces and the medullary canal grow larger and larger, until at length in the more severe forms, all that is left is a cylinder of osseous tissue, as thin as paper, filled with a kind of reddish-brown pulp, and unable to resist a strain of any kind.

In certain people the bones are peculiarly liable to break, without its being possible to assign a reason for it. Their health is to all appearance perfectly good, and the fractures unite without difficulty. This condition, which sometimes affects several members in one family, and which may be hereditary, for want of a better name is known as *Fragilitas ossium*.

(*b*) *Local.*—These are for the most part connected either with inflammation, or with the presence of some new growth of or in the neighborhood of the bone.

*Inflammation*, if the process of repair does not keep pace with that of destruction, of necessity renders the bone more likely to give way. In acute suppurative osteomyelitis, for example, total necrosis and separation of a portion of the shaft may take place before a sheath of new bone can form; or, after this has been thrown out by the periosteum, it may be so weak as to bend or break almost of itself as soon as the sequestrum is removed. The same accident sometimes complicates inflammation and suppuration in the medullary canal, even when there is no sequestrum of appreciable size; and it has been known to occur from rarefying ostitis gradually eating away the interior of the shaft without any corresponding deposit being formed on the exterior. Caries involves the shafts of bones so rarely that in this respect it is of little importance, except in the case of the ribs and the odontoid process.

Separation of an epiphysis, due to softening of the cartilage, is sometimes discovered unexpectedly in the course of acute periostitis and osteomyelitis. It is most often met with at the upper end of the tibia, and union may have taken place in a faulty position before it is noticed.

The most common local cause is the presence of some *new growth*, such as sarcoma or carcinoma. Sometimes the fracture is preceded by swelling or by constant pain, but it is not unusual for there to be no suspicion of anything wrong until one of the bones unaccountably gives way.

Central sarcomata are the most important. They grow from the interior, very often at the epiphysial ends, and replace the bone until there is nothing left but a soft, vascular mass, which may retain the shape of the part, or cause it to expand into a thin-walled cyst. Periosteal ones, as a rule, do not interfere to a sufficient extent with the structure of the bone. Secondary deposits of carcinoma, especially after scirrhus of the breast, may lead to the same result. Apart from the local growth there is no evidence that either the cancerous or the sarcomatous cachexia has any special influence on the stability of the skeleton.

Enchondromata, cysts, and echinococci occasionally weaken the bone which they grow, so that it gives way unexpectedly; and sometimes the same result follows from absorption due to the pressure of external tumors, such as aneurysm.

*Syphilis* occasionally acts as a predisposing cause by the local changes it induces—caries, or much more often gummatous infiltration of the periosteum or bone. *Scurvy* hardly seems to have any influence, except perhaps in the case of the costal cartilages. It is stated that when it is very severe these are liable to be detached, owing to changes which take place at the ends of the ribs, and which are often associated with hemorrhagic periostitis.

Changes of a similar character occur at the ends of the long bones (particularly : lower epiphysis of the humerus) in young infants, as a result of hereditary hilis, and more rarely scurvy, so that the growing ends are liable to be separated very slight degrees of violence. Some of these may be genuine examples of tached epiphyses; in others it is probable the line of separation runs through e softened and infiltrated layer of bone bordering the end of the shaft.

### 2. *Immediate Causes.*

These are either external violence, or muscular contraction, or in some inances a combination of the two.

(*a*) *External Violence.*—This may be *direct* or *indirect.* In fractures by direct olence the bone is broken at the seat of the injury, as when a limb is run over and ushed by a heavy wheel; the fracture is often comminuted and the soft parts riously injured from the way in which they are ground between the offending bject and the bone. In the other variety the fracture occurs at some other, perips far-distant, point, where the strength of the bone or chain of bones is least, nd the soft tissues may escape almost entirely. In falls, for example, upon the utstretched hand, the shock is transmitted through the arm to the clavicle, and his gives way at its weakest point. The two ends are driven together and the bone s bent more and more until the limit is reached.

Fractures at the base of the skull and fractures by what is known as *contrecoup* where the bone is broken exactly opposite the point on which the violence falls) re caused in the same way. The skull, which is exceedingly elastic, is compressed n one of its diameters, the vertical, if the force falls on the vault, and proportionately lengthened in the others; and the bone breaks where it is weakest and most rittle, generally at the base. In other instances, however, as in falls upon the eet, the fracture occurs from the impact of the base of the skull upon the vertebral olumn, as when the head of a hammer is driven home upon the handle by smartly triking the latter on the ground.

(*b*) *Muscular Contraction.*—If it were not for the patella, which very frequently gives way from this cause alone, fractures due solely to muscular contraction would be regarded as uncommon. Sometimes, however, bony prominences, such as the acromion, or the tubercle of the tibia, are torn off by violent muscular action, and occasionally the long bones themselves snap quite suddenly. Many nstances are recorded in which this has happened to the humerus, clavicle, and emur, but in the case of other bones it is exceedingly rare. In most the fracture eems to have been due to the sudden arrest of rapid action, as in striking out at n object without hitting it, and, therefore, to have been caused, in part at least, y the weight and momentum of the arm.

## Repair.

Fractures are repaired, like other injuries, by the effusion and organization of ymph. It is not clear how far this is derived from the blood-vessels, and how ar it is the product of the tissues around. It is certain that the medulla and the leeper layers of the periosteum possess the power of causing the development of ew bone when transplanted into other parts; but, according to McEwen, the superficial ones are quite inert.

### 1. *Union in Simple Fractures.*

*Early Changes.*—There is nothing peculiar about these; the injured parts swell up at once, owing to the extravasation, which is always extensive; the blood pours out from the torn vessels, and spreads in the central cavity, and in the loose cellular tissue around, until it is checked by the tension it creates. After a time t coagulates, and the ends of the vessels become sealed; the fibrin and corpuscles

form a loose, dark-colored mass, which fills up all the interstices; the serum carried away by the lymphatics (the neighboring glands are often swollen at this stage), or, if it is excessive in amount, escapes through the skin and raises up the epidermis in great blebs.

While this is going on, the vessels around the injured area begin to dilate, those in the soft parts first, in the compact bone last, and lymph pours out through their walls; the skin, if the fracture is near the surface, grows warm and red; the blood circulates more rapidly; all the tissues around become softer and more open; the fat is absorbed, and the medulla resumes its embryonic character.

Almost from the first day the coagulated blood begins to lose its color. The red corpuscles break down; the hæmoglobin soaks into and stains all the tissues near, and the stroma and fibrin disappear little by little before the advancing lymph. Probably the white corpuscles share the same fate, though, as in other cases of extravasation, some few on the outside may remain. Meanwhile the lymph grows in from all sides, spreading further and further, until it finds its way between the fragments into the medullary canal, and joins with that which is developed there.

At this stage, up to the seventh or tenth day, the bone itself is almost unchanged; only the surface near the seat of injury is slightly more porous; the periosteum is swollen and thickened, its fibres are softened and separated from each other by masses of lymph, so that its deeper layers are almost gelatinous, and it strips off more readily from the bone beneath. Between the fragments, and lying in the central space, is the debris of the old extravasation; and round the whole is an ill-defined, soft mass of vascular granulation-tissue, mixed with old blood-clot, and inseparably fused with the torn shreds of the muscles and other structures near.

*The amount* of lymph thrown out is regulated mainly by the extent and duration of the injury. In children, it is true, owing to the activity with which all tissue-changes are carried on, the quantity is relatively greater than at other periods of life; but it rarely happens, even in old age, that it is insufficient for the purpose. On the other hand, the wider the extent of the injury, the more the soft parts around the broken ends are crushed and bruised, so long as they are not actually destroyed, and the oftener the injury is repeated, the greater the amount produced. Where a bone is simply broken, with no displacement or extensive laceration of the periosteum, and where the parts are kept at perfect rest (as, for example, in fissures of the cranium), the lymph merely unites the broken surfaces, fills up some of the medullary space, and causes a little thickening of the periosteum. On the other hand, in children; in animals; where there is a thick layer of soft tissue on the bone (and if it is on one side, as in the case of the tibia, on that side only); where the fragments are allowed to move one on the other, as in the ribs; and where there is a number of splinters wounding all the parts around,—a huge mass may be formed, welding everything together, and filling up the medullary canal so completely that it is divided into two.

*Callus.*—This effused lymph becomes ossified, and is known as callus. At first it is soft and porous, very irregular in shape, and perforated in every direction by a number of vessels running from all sides toward the centre; later, it shrinks and becomes more dense, the outer layers remain fibrous, and fuse with the periosteum at either end; the rest is slowly absorbed, until there is only sufficient left to restore the strength of the fractured bone. That part of it which surrounds the broken ends and fills up the medullary canal was formerly called *provisional;* it is formed earlier, and mechanically acts as a kind of splint; that which directly unites the broken ends is *definitive* (Dupuytren); it is not developed until the other has already assumed the form of spongy bone, and after this has disappeared it forms the permanent bond of union.

The former comes from the periosteum and surrounding tissues, and, perhaps to some extent, from the medulla, the latter from the bone itself; but *there is real distinction between them.* The difference in the time of their appearance

e to the relative ease with which the changes after injury take place in soft, llular tissue, and dense, unyielding bone; and the difference in the direction of ir vessels depends solely on the position of the old ones from which the new es spring; they are mainly transverse in the outside callus, because they con-rge from all points on the exterior toward the fractured spot; and they are ngitudinal in the intermediate part when this is once developed, because the old es lie above and below.

Provisional callus is not thrown out, as its name implies, to act as a temporary support, until the definitive can appear and take its place. It is the real bond of union between the broken ends, an attempt to restore the strength of the part with as little delay as possible. If a splinter is detached from the side of a bone, and the periosteum replaced, the hollow is very soon filled with spongy callus, in great excess because its strength is so much less than that of the solid part that has been lost. The bone is weakened and an attempt is made to restore its strength as soon as possible; cancellous tissue can be formed almost at once, while compact cannot, but a greater quantity is required. By degrees, when the vessels in the old bone have had time to dilate, and buds of lymph can grow out from the Haversian canals, some of the newly-formed cancellous bone becomes compact and modeled on the old lines, and then the excess is removed by absorption and the original shape restored.

The same thing occurs in a transverse fracture. Soft callus is thrown out round the ends, because this can be done at once; and the bulk is greater to make up for its feebler strength. Later, when there has been time for the central ring to become compact, the outside part, having no further purpose, is removed, and the original shape regained.

*The ossification of callus* may be preceded by the formation of cartilage or not, but in any case it follows strictly the physiological type of normal growth.

The first deposit of lime makes its appearance on the tenth to the fourteenth day, in the layer of the periosteum that lies nearest to the old bone. Almost from the first, the cells that occupy this part are larger than the rest; many of them are stellate, with one or more nuclei, and all have a large amount of granular protoplasm. The lime is deposited around these, so that if the periosteum is stripped up from the old bone, this is not only porous, but rough, from a covering of little spines and points. Far away from the fracture, at the boundary of the unaltered periosteum, the callus is converted directly into bone, even in animals. The intercellular substance at a distance from the vessels becomes darker; granular patches make their appearance in it, and grow larger and larger until they join together; and a network of trabeculæ, enclosing spaces of the most irregular shape, is built up by degrees. In these lie the vessels, with the cells arranged in concentric masses around. Gradually more and more bone is deposited, layer after layer of cells becomes infiltrated with inorganic material, always closing in toward the centre, until at length the spaces become narrowed down into Haversian canals, lined with lamellæ of soft but true bone.

In dogs and rabbits a very large proportion of the callus, internal as well as external, is converted into cartilage. In infants, too, this takes place to a very considerable extent, but in adults only islets of it are formed here and there, close to the broken ends, rarely or never between them or in the medullary canal. A great deal of it, however, is not true hyaline cartilage; near the periosteum it shades off gradually into fibrous tissue, and in other parts the ground substance differs from the matrix of true cartilage in the way it stains with carmine. In places, too, it becomes converted directly into bone, the cells becoming smaller and stellate, and lime being deposited in the substance between them. Only here and there are there true capsules, which, as in normal cartilaginous ossification, become replaced by vascular buds of small cells, growing in from the surrounding parts.

Absorption begins long before the process of ossification is complete, working in both directions, from the interior of the medulla and the exterior of the

callus, toward the shaft.
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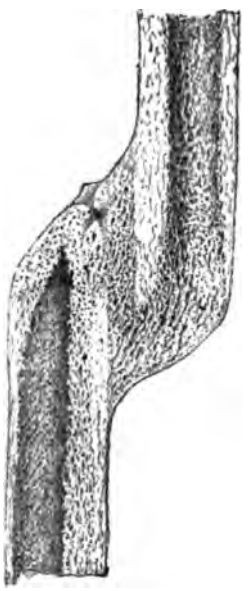

FIG. 109.—Badly United Fracture of Femur, showing the displacement of the medullary canal and the immense increase in density and strength of the bone along the line of direct pressure.

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necrosis, the vitality of the fragment is so feeble that, unless there is impaction, union never takes place.

*Fractures Through Cartilage.*—In the case of the costal cartilages the broken ends are generally held together by a ring of fibrous tissue, formed from the perichondrium and the cellular tissue outside it. Sometimes this is converted into bone and the cartilages themselves are calcified. In young subjects it seems probable that the cartilage corpuscles at a little distance from the seat of injury take some share in the process; those immediately bordering on it break down and disappear.

When the articular cartilage of a joint is split, as in T-shaped fractures, the cleft is filled in after a time by fibrous tissue; and the same thing happens, only very slowly, when a portion is completely detached, the fragment itself remaining as a foreign body.

### 2. *Union in Compound Fractures.*

In compound fractures the process of repair depends upon the behavior of the wound. If this heals by the first intention, or if it is sealed successfully, the tissue-changes are essentially the same as those described already. A certain amount of blood is extravasated, some of the tissues are disorganized and require to be repaired or replaced, but unless the crushing is so severe that the part sloughs *en masse*, the debris is carried away little by little; granulation tissue grows into the space that is left, and fills it, and there is only a slight degree of hyperæmia and swelling, corresponding to the increase in the activity of the circulation.

If, on the other hand, the breach of surface is not closed in at once, union takes place more slowly, and is attended by suppuration of a more extensive character. In the slighter cases, in which the soft parts are not much bruised, or the bone splintered, and in which there is free exit for all discharges, the wound soon begins to fill. The vessels dilate, lymph pours out into the periosteum and the loose tissues around, until they are so swollen that it is not easy to distinguish one from another; the fibrin coagulates on the surface, the serum drains away, and as the new vessels are formed the broken ends of the bone become surrounded and enclosed by a mass of vascular granulation-tissue which grows until the cavity is obliterated. At first the surface of the bone, if the periosteum is stripped off, shows but little change; in a few days a number of minute red dots appear upon it; then each of these enlarges into a little bud of vascular granulation-tissue, springing from the side openings of the Haversian canals, and at length it becomes as porous as the cancellous part, and is covered over with a layer of vascular lymph, continuous with that formed from the structures around.

The granulation tissue is converted directly into bone, without passing through any intermediate stage, and without the formation of cartilage. The lime salts make their appearance first, as in simple fractures, between the cells on the surface of the old bone at the boundary of the injury. From this they advance by degrees toward the injured part, until each of the fragments is surrounded by a ring of soft, spongy callus. These gradually increase in size, approach nearer and nearer until they join across, and unite at length with that which is developed from the medulla. The shape at first is very irregular and the amount excessive, while openings persist here and there in the newly-formed sheath for the discharge of pus; but if there are no sequestra these soon close in and the whole becomes firm and dense.

In many cases, however, the result is not so fortunate. Sometimes it is due to the severity of the original injury; even in simple fractures it occasionally happens that the parts are so crushed and bruised that they slough; much more often it is the result of some fresh additional cause. The wound itself is of a peculiarly unfavorable character, nearly always deep and irregular in shape, divided by the layers of fascia into many strata, the openings of which do not correspond; the external orifice is often small, while the external cavity is always a great deal larger than it appears to be, and it is filled with a material exceedingly prone to decom-

position. If this occurs before the barrier of lymph is thrown out, the produ poison all the tissues near, inflammation of the most intense description follo and unless checked in time spreads up and down the limb until it is thoroughly d organized, or life itself is lost. The periosteum and medulla quickly becom involved; in the neighborhood of the wound itself, where the process is mo intense, they may be completely destroyed. Splinters perish at once, and a thrown off; the ends of the bone, deprived of their blood-supply, undergo necrosi and enormous masses of callus are thrown out round them by the more distan parts which suffer less.

If this happens, when nothing worse results, months often pass before union is complete. A line of demarcation must form round the necrosed fragments; granulations must be thrown out by the living compact bone before the sequestra can be moved; and often, long before this takes place, callus has grown round them and locked them in, so that an operation is necessary to release them. I have known them work their way out more than fifty years after the original injury. Firm union is often established months before the wounds have closed, and sinuses leading down to the interior of the bone sometimes persist for the rest of life.

### Imperfect Repair.

The amount of callus thrown out may be excessive. This is more likely to happen after compound fractures, or when there is a large number of splinters and the tissues around are much irritated. As a rule, it is not of material consequence; the outline of the limb is altered, and the action of the muscles slightly impaired; but the inconvenience is not great, and the excess is soon removed by absorption. Sometimes, however, a nerve is compressed, and paralysis or wasting sets in; or a joint is locked and useless, owing to outgrowths of bone around it; or two parallel bones, such as the radius and ulna, are joined together so that pronation and supination are lost. When this occurs, more active measures are required, and it is generally necessary to cut down upon the offending portion and excise it. These cases of overgrowth must be clearly distinguished from *callus tumors* (enchondromata and osteomata chiefly), of which a very few have been recorded, occurring for the most part, at a much later period.

Occasionally, the callus becomes soft again, and is absorbed to a great extent so that the deformity reappears. This may be due entirely to local causes—necrosis, for example, taking place, at the seat of injury; or it may happen during an attack of erysipelas, and in the course of acute specific fevers. In one or two extraordinary instances the absorption has not been limited to the callus, but has extended to the fractured bone itself. As a rule, only recent fractures, in which consolidation has hardly taken place yet, are affected.

It is more common for the amount to be deficient from the first, or for the process of ossification to fail. Bony union, then, is either delayed, or else never takes place at all; no distinct line can be drawn between them; the causes that occasion the one will, if they act with sufficient persistence and vigor, equally give rise to the other.

1. *Delayed union*, as might have been expected, is met with much more frequently than complete failure. In simple fractures of the leg it is not uncommon to find at the end of four or five weeks that the fragments are apparently unaltered, as easily moved as they were at first. Sometimes a definite cause can be found; but more often there is nothing of the kind. Generally in these cases there has been very little displacement, with little injury to the surrounding parts and consequently the amount of provisional callus is exceedingly small. Or the fragments may appear to be united, there may be no pain or undue mobility when the limb is tested; but a few days after the patient is allowed to get up the union begins to bend, and it is clear that the callus is not sufficiently firm. In the vast majority of instances this gets well of itself; the limb is straightened; a fixed apparatus, rather stronger than usual, is applied; and the patient is allowed t

[illegible] about on crutches, with a strict injunction not to let the injured limb touch [illegible] ground under any circumstances; but every now and then the reverse takes [illegible]ce, the callus becomes absorbed, from too early movement, the union becomes [illegible]eaker and weaker, and a false joint results.

2. *Non-union.*—When there is no bony union at all, the ends may remain separate and distinct, without so much as a band between them; or they may be connected together by fibrous tissue of various degrees of strength; or they may lie in apposition, held by a capsule of connective tissue, so that a more or less perfect joint is formed.

[Interposition of muscles between the fragments may sometimes cause non-union.]

(*a*) ***Absolute non-union*** is rarely met with except in intracapsular fracture of the neck of the femur, and in some cases of fractured patella. It is nearly always due to wide separation of the fragments. The medullary spaces become closed;

FIG. 110.—Ununited Fracture of Ulna.

FIG. 111.—Ununited Fracture of Tibia with Consecutive Bending and Strengthening of Fibula.

FIG. 112.—False Joint in Tibia from a Fracture, Probably at Birth.

the ends become rounded and wasted; the surfaces, if they are in contact with other hard structures, become dense and polished; and the callus that is thrown out after the fracture is absorbed again.

(*b*) ***Fibrous or imperfect union*** is much more common. Sometimes it is exceedingly firm; the ends of the bones are well nourished; the broken surfaces face each other; the fibres that pass across are short and strong, with, perhaps, islets of cartilage and even of bone scattered among them, so that it is difficult to be certain that perfect union has not taken place. Sometimes, on the other hand the fibres are long and weak, formed rather by a condensation of the connective tissue around the ends than from a layer of callus directly connecting them; and the bones are thin and conical, with their ends much wasted. Every grade, in short, may be found, between union that is nearly as strong as bone and absolute failure.

(*c*) ***False joints*** (pseudarthroses) strictly so called, are rarely met with.

They appear to be formed out of false union in simple fractures by constant movement for months together. In some cases they are almost perfect; the ends are moulded so that they fit each other accurately; they are surrounded and held together by a tough ligamentous capsule; this is lined with a layer of flattened connective-tissue corpuscles like an endothelium, and is filled with a fluid which, as in the case of adventitious bursæ, closely resembles synovia. Sometimes islets of cartilage, hyaline or fibrous, may be found upon the apposed surfaces, probably the remains of the callus that was thrown out shortly after the fracture. More often the surface is dense and polished, as in joints affected with arthritis deformans; and lips, fringes, and even loose bodies are occasionally found around the margin. False joints of this description are most frequently met with in the humerus and femur, possibly owing to the peculiarly dense character of the compact tissue.

They have been known to occur in children, especially in the leg, and to lead to impairment in the growth of the limb. When they occur in adults, the bones and muscles are often well nourished, much better than they are in cases of fibrous union.

**Causes.**—The causes of delayed union and false joints may be general or local; but the latter are by far the more important.

FIG. 113.—Position Assumed by the Limb in this Case before it was Amputated.

1. *General Causes.*—Very few can be regarded as more than occasional; union is sometimes delayed; but more often than not it takes place as quickly as in health. Fevers, Bright's disease, diabetes, scurvy, starvation, advanced syphilis or carcinoma, pregnancy, lactation, any severe cachexia, in short, may check the progress of repair, but though undoubted instances are recorded, it is rare to find that any one of these is sufficient by itself. Sometimes the urine has been found to be alkaline and loaded with phosphates, and it has been thought that this was the reason, and in a very few cases it has seemed as if the fault lay with the nervous system. Old age is certainly not a cause; fractures unite as well in people over seventy as in younger ones, with the exception of intra-capsular fracture of the neck of the femur, the reasons for which are probably entirely local. Complete failure may nearly always be traced to local causes.

2. *Local Causes.*—Some of these, like the general ones already mentioned, merely delay union: others prevent it altogether; but with a few exceptions it cannot be said even of these that they are invariable; and in a large proportion of cases it is impossible to give a definite reason why union fails.

(*a*) *Separation of the Broken Surfaces.*—This is the most important; if the space between the fragments is filled up with other structures, whether muscle, tendon, joint-capsule, or blood-clot, so that they cannot be brought together, failure is almost certain. It does not matter how the separation is produced;

ends may be driven into the substance of other structures near; or drawn art by the action of muscles; or made to overlap so that the periosteal surfaces ly are in contact; unless they are properly adjusted the result is almost certain. on-union is more frequent in compound fractures than simple ones, owing to e amount of bone that is sometimes lost by resecting the ends, or from necrosis.

(*b*) *Movement.*—In other instances the method is in fault; either the fragments are not properly secured, and the neighboring joints not fixed as they should be, or movement is allowed too soon, and the callus is absorbed again. This happens in a variety of ways: the bandages may become loose from shrinking of the limb; the patient may be delirious; surrounding circumstances may be unfavorable, or a neighboring joint may become stiff, so that when the limb is used an undue strain falls upon the seat of fracture. One of the favorite sites is the middle of the shaft of the humerus, and it is certainly not uncommon to find in these cases that the elbow is stiff; but I am disposed to think that more importance should be attached to the peculiarly dense character of the bone at this spot, and to the possibility of slips of the neighboring muscles getting in the way. In the case of sailors, among whom cases of ununited fracture are unusually frequent, full allowance must be made for defective hygienic conditions, although, admittedly, fractures of the ribs rarely fail to unite in them.

[The experience of the editor in many years' service in the Marine Hospitals of the United States does not sustain this view as to the frequency of non-union in fractures among sailors, although he cannot recall a single instance of non-union of the ribs, as having fallen under his observation. The cases of non-union among sailors that he has seen were of the long bones, and were due to either lack of proper attention on shipboard before arriving in hospital, or to constitutional syphilis. In the latter, there was no effusion of callus, nor could exudation be excited by ordinary means of treatment.]

(*e*) *Malnutrition.*—The prolonged application of cold, ligature of the main artery, tight bandaging so as to interfere with the circulation, thrombosis of the veins leading to œdema, and rupture of the nutrient vessels, are all cited as occasional causes: and no doubt they are not without some influence, although it is difficult to believe they are sufficient of themselves. It has not been proved that the nerves exert any direct effect.

(*f*) *Disease of the bone itself* is an occasional cause. Necrosis has been already mentioned as especially frequent in compound fractures; but tertiary syphilitic nodes, mollities ossium, atrophy, hydatid cysts, sarcomata, and chronic abscesses sometimes lead to the same result.

**Diagnosis.**—This rests mainly upon the degree of mobility that is present. In cases of delayed union it is usually slight, though the amount of deformity may be considerable, and it is always painful; in fibrous union or false joint, on the other hand, it is free and nearly painless. The probability of the latter increases greatly with the length of time since the accident; but union of a fractured femur has been known to take place without operation after as long an interval as twenty-two months.

**Treatment.**—Like the causes, this is general as well as local; but while the former may prove serviceable in mere delay, it is entirely without effect in genuine cases of false joint.

1. *Constitutional.*—This naturally varies with the requirements of each case. Nourishing food and fresh air are essential in all; tonics are often needed to improve digestion: a fair amount of stimulants is advisable, especially in those who are accustomed to them; and iron, cod-liver oil, and other remedies may be given to improve the general health; but there is no proof that the administration of lime or of phosphorus in any shape has any effect upon the deposition or the ossification of callus. In cases of syphilis, mercury and iodide of potash must be given according to the general rules; and mercury has been given experimentally with success where no history could be obtained: but, apart from the presence of gummata upon the bones, it very rarely happens that union is in any way delayed by this disorder. Vegetables and lime-juice are equally important if there is any suspicion

of scurvy; and a woman who is suckling should be directed to wean her infa
but, beyond general considerations of this character, nothing can be done. Th
is no evidence that any drug has the least direct influence on the rapidity w
which union takes place.

2. *Local.—Readjustment.*—The first thing, if the ordinary time has elap
and the fragments are still movable, is to reset them, bring them into apositi
with each other, and secure them in some form of splint (a fixed one generally) th
will ensure absolute immobility, and at the same time enable the patient to
into the open air. This alone is sufficient in a large proportion of cases, especia
those in which the chief cause is want of rest. Only it is necessary to make c
tain once for all that the fragments are really in apposition, and that nothing h
slipped in between. Should this have happened, union is almost certain to fa
and unless the ends can in some way be disengaged and brought together, it
scarcely worth while wasting time in trying measures that must be ineffectual.

*Counter-irritation.*—This may be combined in some instances with the u
of counter-irritants—tincture of iodine, for example, painted once every night, o
light blisters. These no doubt do increase the amount of blood flowing throu
the parts beneath; the exact form of a blister painted on the thorax may be trace
sometimes upon the costal pleura; and where a bone is near the surface, as in th
case of the leg, the periosteum would almost certainly be stimulated to increase
action; but at the best they can only be of very limited application.

*Mechanical Stimulation.*—If this procedure fails, an attempt may be made t
excite a certain degree of inflammation by friction or percussion, and then to ob
tain union by securing the fracture in a plaster case. One method is to rub th
ends of the bones together every day, until a certain amount of heat and swelling
is produced around the seat of fracture. Another aims at the same effect by ham-
mering them with a mallet, the skin being protected from injury by a piece of felt.
A third, which is sometimes successful, not only in delayed union, but even in case
of false joint of long standing, consists in encasing the limb in an apparatus so con-
trived that the patient may get about, while the fragments are held rigidly fixed
and in contact with each other. This is especially useful in fractures of the lower
limb, where there is already a fair amount of union, and where the direction is not
too oblique. The appliance, which must be worn night and day, naturally must
be fairly strong, and must fit with the greatest accuracy. The best are made of
leather, with lateral iron supports, jointed in the proper situations, and let into the
boot beneath. The health of the patient improves; the nutrition of the limb
becomes more satisfactory; and the constant friction of the ends of the bones
stimulates them to such an extent that in many instances the fracture unites and
becomes firm without anything further being required.

*Puncture and Incision.*—When it is no longer a question merely of delay, the
same kind of treatment may be adopted, but in a more vigorous manner. If the
bone lies near the surface, it sometimes answers to drive a number of stout needles
directly through the skin into the space between the fragments, and leave them
there for a week or ten days. In other cases the injection of various kinds of fluid,
tincture of iodine, carbolic acid, and alcohol has been tried. Or the negative pole
of a galvanic battery has been attached to a needle inserted between the fragments,
and a current as strong as the patient could bear without an anæsthetic passed
through it; or the ends have been scarified with a tenotome, or perforated with a
drill, with the view of exciting sufficient inflammation about the part to fix the
fragments by the exudation. None of these, however, can be advocated very
strongly; acupuncture and drilling the ends are perhaps the most satisfactory, but
they are not so devoid of danger as they seem to be, especially as the large blood-
vessels are often adherent to the fragments, and their action is by no means
certain. Setons should certainly not be used.

*Nélaton's Operation.*—Of all the methods that act in this way, the one that has enjoyed
the greatest amount of success is that first practised by Dieffenbach. According
to his directions, a small incision is made through the soft parts down to the bone

the side that is most accessible, and both fragments are drilled completely ough; then an ivory peg is driven into each with a wooden hammer, until its can be felt projecting on the other side, and the fracture secured in a plaster ing. The pegs may be left in for ten days or a fortnight, according to the ount of reaction they cause.

It is generally found when the pegs are removed that the surface is deeply ded (after the fashion of Howship's lacunæ) by the cells in the medulla; and it much simpler to break them off short, and leave them in the substance of the e, to be absorbed there; they do not of themselves excite suppuration, the skin nd can be closed at once, and there is much less chance of inflammatory com- ations setting in. In very oblique fractures, where the ends of the bones over- , an additional amount of security may be obtained by driving the pegs through th, so as to pin them together; and steel screws may be used in the same way, e handles being detached after they are fixed, so that the whole can be covered in one dressing: but if measures of this kind are adopted, it is more satisfactory expose the ends of the bone thoroughly, resect them if necessary, and adjust em accurately. The operation is scarcely, if at all, more severe and the result is cidedly more certain.

*Resection and Wiring.*—In a large number of cases this is the only plan that ers a reasonable prospect of success. Where there is a false joint of long stand- g, or great displacement of the ends, or when some foreign substance has become ntangled in the fracture so that the bone cannot be released, nothing else can be f any avail. The immediate neighborhood of a joint is no objection; if the tissues emselves are healthy, and if there is no great amount of inflammatory exudation ound the part already, there is no reason why suppuration should occur. A cer- ain amount of stiffness may result, it is true, either from the formation of adhesions r from excess of callus, but it is rarely of any extent, and, of course, such an peration as this is not done unless the usefulness of the limb is seriously impaired.

The operation itself, especially in the case of a deeply-seated bone, is by no means easy. The limb is rendered bloodless; the parts thoroughly exposed by a longitudinal incision, if possible, through one of the inter-muscular septa, so as to avoid injury to other structures, all intervening tissue removed, taking especial care to preserve every fragment of periosteum, and the ends either sawn off or thoroughly freshened. It is of little or no use unless they are made to fit each other accurately, over a surface of some extent, and are firmly held together. They may be secured in various ways according to their shape; sometimes, when they are both oblique, they may be pegged through with wire or ivory needles; in other cases they may be dovetailed or wedged into each other; in one example the lower end of the fibula was driven into the medullary canal of the upper end of the tibia with a very good result; or if the central canal of both fragments is exposed, an ivory peg may be fixed, first in the one and then in the other, so as to hold them in the same straight line; but the ordinary method is to drill them both, and suture them to- gether, either with silver wire (the ends of which can be hammered down) or kan- garoo tendon. Especial care must be taken to provide sufficient drainage; owing to the amount of manipulation to which the parts must be subjected in an operation of this kind the oozing is in general very extensive.

Even this is not always successful. A great deal depends upon the condition of the bones; if they are much wasted, and if the ends are sharp and pointed, failure is not at all unlikely. Sometimes, when a first attempt under strict antiseptic pre- cautions does not succeed, a second without is more satisfactory, and union has taken place after an attack of erysipelas. Perhaps the best thing, if the opera- tion fails, is to put the limb up in some apparatus that will allow it to be used to a certain extent, in the hope that, though this may not improve the chance of union, the bones will be better nourished, and then another attempt may be made later on.

*Transplantation.*—Nussbaum, in two instances in which there was a great deficiency in the ulna, separated a portion of bone from one of the ends, leaving

it attached by periosteum, and reflected it, so that it filled up the interval. If this is attempted, the circulation through the bone must first of all be stimulated by inserting needles into it, and great care must be taken to prepare the bed for the new fragment.

*Grafting.*—MacEwen has carried the process further still, and by dint of repeatedly grafting in fragments of bone obtained by osteotomy, succeeded, in a child, three years old, in causing the reproduction of nearly the whole of the shaft of the humerus. Fragments of bone and periosteum obtained from animals have also been used, and with success; in one instance, a gap of two and three quarters inches in the clavicle was gradually filled up by grafts of bone from dogs, three successive series being used; and, in another (McGill), thirteen fragments of bone from the femur of a rabbit were transplanted into a gap in the radius with a perfect result. It is possible, of course, that this may be due merely to the irritating effect of a foreign body; but it is difficult to believe that the nature of the foreign body is of no importance.

## Symptoms and Diagnosis.

A fractured limb must be made secure at once, to avoid further injury. Full and detailed examination is better postponed until the splints and other appliances are ready, that the fracture may be set, without being handled a second time. The extent to which it is advisable to carry the investigation and the question of an anæsthetic, vary in each case, and must be left to the discretion of the surgeon. In some instances, such as fracture of the neck of the femur in an old person, manipulation should never be attempted; on the other hand, in an injury to the lower extremity of the humerus, it is absolutely essential to find out the exact position and direction, if serious deformity is not to result.

The possibility that neighboring structures, especially arteries and joints, are injured too, should never be forgotten, and a careful examination into their condition should be made in every case; they may easily be wounded by splinters and in other ways, and, if overlooked, may lead to very grave complications.

*Method.*—No pains should be spared to obtain a clear account of the accident, whether the injury was the result of direct or indirect violence, or if it was due to muscular action—sometimes a sound is heard at the moment that the bone gives way—then what happened afterward, whether the limb was used again, or if all power over it was gone, and where the pain was most acute. In many cases a shrewd suspicion may be formed from this alone, not merely as to the part of the body which has been hurt, but even as to the kind of injury sustained.

Then, before it is touched further than is required for the removal of the clothes (which should be cut wherever necessary), it must be inspected with the greatest care, and compared, point for point, with the corresponding part of the opposite side. Often, the position is characteristic of some special kind of injury; sometimes the outline is greatly changed, natural hollows perhaps are obliterated, or bony prominences have disappeared, or measurement even by the eye reveals an amount of shortening or displacement that can be accounted for in no other way.

Not till this is finished may the part be handled, and then as lightly as possible, beginning at some distance from the supposed seat of injury, and tracing down with the finger the prominent ridges or crests of bone. One spot may be more tender than the rest; nearly always there is swelling either from the extravasation of blood, or from displacement of the broken ends; sometimes, there is discoloration, or the skin is abraded and even torn. All this must be noted before any attempt is made to move the part, either for the purpose of eliciting crepitus, or of ascertaining the presence of abnormal mobility. This, if it cannot be avoided altogether, must be postponed to the last. It must never be forgotten that, in all cases, a great deal (in fractures by indirect violence nearly the whole) of the injury sustained by the soft parts is due to the movement of the broken ends.

**Symptoms.**—The three distinctive signs of fracture are an alteration in the shape of the part due to the displacement of the broken ends, undue mobility, and crepitus, or rough, grating sensation, or crepitus, felt when one broken surface is rubbed against another. The presence of any one of them is enough; when they are all three wanting, as in fissures of the cranium, the existence of a fracture is only a matter of inference.

1. *Deformity.*—Of these three displacement is the most valuable, as it requires little manipulation, and is the one most often present. Sometimes it is so considerable, that it is visible to the eye at once; more often it can be felt beneath the skin, but, in most instances, it is only possible to make certain by means of measurement. In the limbs, comparison with the opposite side of the body is an absolute rule. In some cases, a fairly accurate estimate may be made with the hands alone, grasping, for example, the anterior superior spines of the ilium, in a case of injury to the upper extremity of the femur, and measuring with the fingers the relative position of the trochanters on each side. In general, as the displacement is so often longitudinal, it is done much better with a measuring-tape or a sliding graduated rod. The points selected on the two sides should be well marked, and must absolutely correspond; the position of the limbs must be identically the same, and, as asymmetry is not at all uncommon, it is often advisable to measure not only the length of the whole limb, but that of the individual segments. This is particularly necessary in the lower extremity; whether from previous injury or disease, or from some difference in the rate of growth, it is not at all uncommon to find one of the lower limbs considerably longer than the other.

The direction of the displacement depends chiefly on the character of the part that is injured. It may be angular, as in a greenstick fracture; transverse, or lateral, when a flat bone is concerned; circular, as in fractures of the lower extremity, with eversion of the foot; or longitudinal, the ends either being drawn apart as in transverse fractures of the patella, or approximated so that they lie side by side and override each other. In some cases, when, for example, one is so driven into the substance of the other that it becomes impacted there, deformity is the only one of the three cardinal symptoms present; occasionally, it is absent, as in fissures of the cranium, or when only one of a pair of bones is broken.

In impacted fractures, the displacement is entirely the result of the original force: in other cases, it depends to a great extent on causes which continue to act after the bone is broken, so that it grows worse and worse the longer the fracture is left to itself. The most serious is the contraction of the muscles, not merely the tonic shortening which results naturally as soon as they are released from their state of tension, but violent and continued spasmodic contraction, due no doubt to the irritation caused by the broken ends. This is responsible almost altogether for the separation when a bony projection is wrenched off, and for the shortening which is nearly invariable in fractures of the long bones of the limbs, and, therefore, in cases of paralysis, displacement is always slight. In other injuries, the weight of the limb and, what is a great deal worse, subsequent attempts at moving the part, either by the patient himself or by others, often add seriously to it. Indeed, it is in great measure owing to these two last-mentioned causes that so many fractures by indirect violence become compound.

2. *Abnormal Mobility.*—Abnormal mobility, when it is present, is conclusive, but if the degree is slight, or if the fracture is in the neighborhood of a joint, it is very hard to appreciate, and, if there is impaction, it is wanting altogether. It is most plain in transverse fractures of the shaft of long bones, where there is only one; in injuries of short bones, or where one fragment is so small or so deeply placed that it cannot be fixed, it is of little or no assistance, and though it is nearly always present when one of a pair of bones has given way, special manipulation is generally required to show it. If, for example, the radius is in question, the thumb of one hand must be placed upon the head of the bone, while the other alternately pronates and supinates the forearm; if the lower end of the fibula, a finger must be pressed firmly on the suspected spot,

while the upper part of the two bones are squeezed together, or the foot is forc inverted and everted.

Manipulation of this kind must be carried out with the greatest gentle not merely because it is so painful (this may be prevented by an anæsthetic), because it inflicts such injury on surrounding structures. For this reaso some fractures, of the spine, for example, any attempt should be absolutely hibited.

3. *Crepitus.*—Crepitus, the peculiar sensation, partly felt, partly heard, one broken surface is made to rub upon another, is still more limited in its a cation, for in order to produce it the fragments must not only be freely mov but in actual contact, or at least so close that they can be made to touch. they are fixed or widely separated, or if a piece of fascia or muscle, or even bl clot, has slipped between, it fails completely, and when an epiphysis is detach especially in very young children, it is so soft and faint that it can scarcely recognized. Other sounds, too, resemble it more or less closely; if a syno sheath or bursa is inflamed, or if there is a collection of extravasated blood neath a layer of dense fascia, such as is not uncommon in the region of shoulder, direct pressure may cause a sensation that is almost identical; but, a rule, it only does so once, and the sensation cannot be repeated at the same p till some little time has elapsed. Single clicks, too, something similar in char ter, may often be felt near joints that have been injured when they are moved certain directions; and sometimes, as in the elbows of children, in whom t bony prominences are naturally low, and often still further concealed by swellin they may be so clear as to cause a momentary doubt.

In rheumatoid arthritis, when the cartilage has disappeared from the articula surfaces, and the polished bones are rubbed upon each other in every movemen of the joint, the sound is almost identical, but the feeling is much smoother, an the surfaces do not grate on each other in the same way.

The sudden sound that is sometimes heard at the moment of the accident not only by the patient, but even by those standing near, is rarely of any assistanc in diagnosis, as it only occurs when a long bone is broken, in circumstances tha nearly always cause much displacement.

*Pain.*—In addition to these, there are other symptoms which are not confine to fractures, and which, therefore, can only be regarded as proof when there i other evidence in support of them. Intense pain at the seat of injury, for ex ample, is nearly invariable, but to be of any use in diagnosis it must be constan and limited to one particular spot. If, for example, pressure on one part of a rib always causes pain at another, or if after the foot has been twisted an exceed ingly painful spot is found on the fibula, an inch or two above the ankle joint, fracture more or less complete is almost certain; there is nothing else that can explain localized tenderness so far from the seat of injury.

*Ecchymosis.*—Extensive ecchymosis again is a common occurrence in case of fracture, but is of little use in diagnosis, unless it has the support of other signs. Hemorrhage from the ear, for example, is generally present in fractures through the middle fossa of the skull, but it is only conclusive when it is sudden and profuse; and staining of the skin is not in any way peculiar, unless it is accompanied by localized tenderness and it is certain that the part itself was not directly hurt.

*Helplessness.*—Inability to make use of the part is very general, but by n means invariable. It depends, of course, upon the size and importance of th injured bone and the extent to which it is hurt. If the ends are impacted, or th periosteum is not torn, or if only one bone of a pair is broken, the limb may sti be used to a certain extent, though not without pain. In some cases of fracture the clavicle, it is quite possible to raise the arm above the head, and persons wi impacted fracture of the neck of the femur have been known to walk about f days. When, on the other hand, the bony support for the leverage of the muscl is lost, this is absolutely impossible. Unhappily, this symptom is not confined

ctures, but is present in other injuries, too, particularly in those which present e closest resemblance to them.

**Diagnosis.**—The diagnosis of fracture has to be made from separation of piphyses, dislocations, and contusions. Injuries in the neighborhood of joints, erefore, present the greatest difficulty, and if the examination is delayed until elling has set in, or if the joint has been previously the seat of disease, particularly of rheumatoid arthritis, it may be necessary to wait for some days and to atch the progress of the case before a definite opinion can be given. In such a se the injury must always be treated as if it was certain that the bone was really oken.

The separation of an epiphysis is distinguished by the locality, by the age at hich it occurs, and by the peculiar soft character of the crepitus, when it is pres-t; in infants it may be absent altogether, as the line of detachment in them s in the substance of the cartilage. The amount of displacement is rarely very eat, as the periosteum belonging to the shaft is closely attached to the epiphysis, nd is so tough that it is seldom torn completely in two; but sometimes, when he end of the shaft is near the skin, its smooth and rounded shape can be distinguished from the sharp outline of a fracture. The diagnosis is important, because in a certain number of cases this accident is followed by an arrest of growth, and it is advisable that the possibility of such an occurrence should be pointed out at the time. When there is only one bone, as in the arm, there is merely a certain degree of shortening, and if the upper end is in question, some restriction in over-hand movements; but when the lower end of the radius fails to grow, the styloid process of the ulna projects further and further until the use of the hand is seriously interfered with and the appearance is very unsightly.

Dislocations rarely present any difficulty if the injury is seen shortly after the accident, before swelling has set in and the bony prominences are obscured. If displacement is once rectified, there is no tendency for it to return; true crepitus is wanting, though sometimes there is a very fair imitation, and there is no abnormal mobility. The position of the limb is fixed, and can only be altered by the exercise of a certain degree of force. It must not be forgotten, however, that fractures sometimes occur with dislocations, and that, particularly in the case of the elbow, fractures into joints may be accompanied by a degree of displacement that produces a very close resemblance.

Severe contusions, in which there is complete loss of power over the limb or a considerable extravasation of blood, in many cases cannot be distinguished from impacted fractures, and should be treated as such. It is impossible to prove that the crushing force has been expended entirely on the soft parts, and has not reached the bone, without handling the part to an extent which, in such injuries, is certainly not advisable.

### Course and General Complications.

*Shock.*—All fractures of any consequence are attended by shock and followed by a certain degree of fever. The former of these is dependent, not only on the fracture itself, but on the extent of the injury the soft parts have sustained, the way in which the accident happened, and the condition, mental as well as bodily, of the patient at the time. I have known a man whose great toe was run over by a railway engine, so collapsed that twenty-four hours passed before the reaction was sufficiently good to justify an operation.

*Retention.*—Retention of urine for a day or two is present in a large number of cases, especially when the fracture involves the pelvis or the femur, and when the patient is confined to bed.

*Fever.*—In simple fractures, and in compound ones in which the wound heals by the first intention, the fever rarely reaches any height. It is traumatic fever in the strictest sense of the term. The same evening there is, generally speaking, a fall of temperature due to the shock; the next day it is slightly raised, and

it reaches its maximum, 100° or 101° F., by the evening of the second day. To some extent it is due to the pain and tension upon the sensory nerves of the part, and, as a rule, it is proportionate to the amount of extravasation; but the main cause is the gradual absorption into the circulation of the blood ferment set free by the injured tissues, and the broken-down clot which fills the wound.

If, on the other hand, the fracture is compound and the wound does not heal by the first intention, or if, as very rarely happens, the limb is so injured that though the skin is unbroken, it becomes gangrenous, no rule can be laid down either as to the kind or the degree of the fever. It depends entirely on the complications that set in and the extent and severity of the inflammation by which they are accompanied.

*Fat Embolism.*—Fat embolism occurs probably in every fracture. It comes no doubt, mainly from the medulla, but as the amount found in the lungs is sometimes too great to be accounted for in this way, it may be derived to a certain extent from the subcutaneous tissue as well. Large veins are torn across, their ends are held open, the pressure in their interior is exceedingly low, that in the space around from various causes much higher, and as a consequence the contents of the broken fat-cells and the extravasated blood are taken up and carried away by the current. It commences almost at once. I found abundant evidence of its presence in the lungs of a man whose death was almost instantaneous from a broken neck; and it continues for some weeks, the drops of fat circulating in the vessels becoming broken up as they pass through the capillaries, and reuniting again in the larger trunks until they are finally excreted by the kidneys.

The clinical significance of this complication has been very variously estimated. There can be no doubt that in the vast majority of instances it gives rise to no symptoms at all, and animals, at least, are not materially affected when four times the quantity of fat contained in a femur is suddenly injected into one of the larger veins. When the amount is greater than this, there is a conspicuous lowering of temperature, difficulty of respiration, and evidence of heart-failure. The same symptoms have occasionally been observed after simple fractures in man, and may, with a fair amount of probability, be assigned to this. Collapse is always prominent, not immediate, as if it were due to shock, but coming on after an interval of some hours; the pulse is small and quick, respiration hurried and shallow, the temperature falls rapidly, the face becomes pale, there is a feeling of great weakness, the senses gradually become more and more dull until death ensues, perhaps preceded by convulsive attacks. In the case of compound fractures it is, generally speaking, impossible to decide how much is due merely to the mechanical influence of fat embolism, and how much to acute septic intoxication, which is frequently present in the same kind of case.*

It is a very old observation that sometimes after fractures an oily scum forms upon the surface of the urine after it has been allowed to stand, and it seems probable, when this happens, that it is due to the particles of fat which are excreted by the kidneys in a state of molecular subdivision. It is not common, however, for the amount to be sufficient to produce this effect. Oily and albuminous casts have also been described, but their presence is certainly unusual.

The further course of a simple fracture is, as a rule, quite uneventful. The swelling of the limb gradually subsides and becomes localized to the immediate seat of injury, where, owing to the callus that is thrown out around the broken ends, it may persist for months. The extravasated blood is slowly absorbed, the discoloration sometimes showing itself in far distant parts of the limb. Occasionally blebs filled with serum, more or less deeply stained, make their appearance by the side of pads where there is little or no pressure. These should be pricked, their contents absorbed with wool or blotting paper, and carefully dried, or, particularly if there is much œdema, they may prove the starting point for some inflammatory process.

* See Paper by author in *British Medical Journal* for July, 1881.

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If a fragment is detached, the con-
it is small, it merely causes a transient
a branch of the pulmonary artery;
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nnection with fractures are immediate
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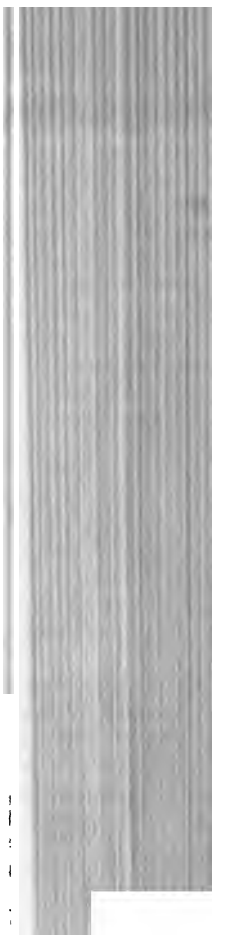
Cases of injury to important viscera



coats give way and curl up in the interior of the vessel; or it may be torn pletely in two. Sometimes, therefore, it is blocked (though it may give way l and sometimes it continues to bleed until it is stopped by the tension of the t around or by the failure of the heart.

If there is a wound, the nature of the complication is generally evide once, though when the external opening is very small and tortuous the stream be continuous instead of coming in jets. In simple fractures the symptoms de upon the size of the artery and the nature of the injury. If one of the l trunks is torn across, a tense, elastic swelling forms with great rapidity, there i most excruciating pain, the pulse below is completely lost, and the limb bec cold, œdematous, and numbed. If, on the other hand, there is only a punc so that the continuity of the vessel is not interrupted, this takes place more slo a certain amount of indistinct pulsation may be felt for a time, and sometim least, a low murmur may be distinguished, synchronous with the pulse.

(*a*) *In Compound Fractures.*—In the case of a compound fracture, i vessel is of any size or importance, the choice of treatment is very limited; e the wounded artery must be found and tied above and below, or the limb mu amputated. Which of these alternatives is adopted in any particular case dep upon the patient, on the particular artery that is wounded, and on the exte the injury inflicted on the other structures around. Obviously, a much gr risk may be run with a child than with an adult, though children bear hemorr badly; there is much more hope when the upper limb is in question; and prognosis is much better when the fracture has been caused by indirect viol than when the soft parts are crushed, the collateral circulation destroyed, and neighboring joints torn open.

The hemorrhage must first be checked by a tourniquet, or other means s to the part, the wound enlarged, all clots turned out and a thorough search m Sometimes this is successful, but finding a torn vessel under conditions such as t is always a matter of the greatest difficulty. Ligature of the vessel higher up not be recommended; if the collateral circulation is good, the bleeding contin if it is not, gangrene sets in.

(*b*) *In Simple Fractures.*—In simple fractures the question turns upo collateral circulation and the limitation of the extravasation. If the swellin tense and diffuse, so that the limb below is cold and pulseless, amputation mu performed at once before gangrene sets in. The only exception is where the rounding structures are but little injured, and the interruption to the circul is due more to the tension than to the destruction of the collateral vessels. O sionally this happens to the popliteal; an attempt may then be made, prov everything else is favorable, to find and tie the injured artery, but it must be r lected that this makes the fracture a compound one, and that very often it ext into the knee joint.

If, on the other hand, the circulation is not completely interrupted, if limb still retains some warmth and sensation, there is some hope either that a t matic aneurysm will form, or that, better still, the wound in the artery may c and the blood quietly become absorbed without further trouble. I have kn this happen even when it was practically certain, from the extent of the extra tion, that the brachial artery had been torn across. The limb should be ra kept quiet, placed in as comfortable a position as possible, and wrapped in cot wool to maintain the temperature. No firm bandages or splints may be appl merely something to protect the part against incautious movement; the best l lies in perfect rest and gentle compression.

In the case of the anterior tibial the symptoms sometimes disappear of th selves; more often the swelling continues to pulsate without extending very rap and a wall, more or less perfect, is gradually formed around the hæmatoma un becomes a traumatic aneurysm. This may be cured at any time by any of ordinary methods; compression may be tried first; if this fails the artery ma tied above, or the sac may be laid open and both ends of the vessel secured. (

*Injury to Joints.*—Extension of the fracture into a neighboring joint is al a grave complication, even when the skin is unbroken. The synovial cavi filled with blood; it is often difficult to restore the fragments to their p position, and still more to keep them there; and for fear of the joint beco stiff, passive motion has to be commenced at a very early period, long before union is sound enough for use. Moreover, later in life, a joint that has b injured in this way is very liable to be attacked by an obstinate form of o arthritis. When the fracture is compound, the danger is greater still. The c that is opened up is often of very great size and very irregular in shape; and i lined with a membrane exceedingly prone to absorb any poisonous material tha present. Under these circumstances, it is scarcely surprising that the danger accute suppurative arthritis is so great.

Dislocation is occasionally, but very rarely, associated with fracture, the bo being forced from its socket, and then broken by the continuance of the s force. No pains should be spared to effect reduction. The patient must b placed under an anæsthetic, the limbs secured by means of splints, and the displaced part of the bone, if possible, pushed back. If this does not succeed, either the joint must be laid open and the head of the bone dislodged and restored to its position, or the fracture must be set and another attempt made later when the bone is firmly united.

*Inflammation.*—Inflammation in the course of a simple fracture is quite exceptional. Sometimes, when the extravasation is very extensive, the hæmatoma slowly suppurates, as it does occasionally in contusions; or inflammation starts from the blebs that form on the surface of the skin; and sometimes a slow, chronic form of ostitis sets in afterward, akin, perhaps, to the arthritis that follows contusions about joints; but this does not occur unless some additional cause is at work.

In compound fractures, on the other hand, if the wound does not heal at once, it often proves a most serious complication. Erysipelas, cellulitis spreading through the deeper planes of areolar tissue, as well as the superficial ones, diffuse suppuration, acute periostitis, osteo-myelitis, septicæmia, pyæmia, hectic, every form of wound disease, in short, may break out in the course of treatment, and either delay recovery indefinitely by the sloughing and necrosis it causes, or itself prove fatal.

*Sloughing.*—Sloughing of the skin and cellular tissue may be caused by the violence to which the part is subjected at the moment of the accident; or may occur, as already mentioned, from the pressure of badly-made splints on bony prominences. In the former case the fracture is almost certain to become compound if it was not so already; in the latter the slough often bears no relation to the seat of injury, and, so long as it is limited, may be treated as an ordinary bed-sore. All pressure must be removed, so far as is consistent with safety; the position of the limb must be adjusted so that the circulation is unimpeded, and putrefaction prevented. If the cause is removed and no fresh irritant allowed to appear, the sore that is left soon granulates up.

*Gangrene.*—Traumatic gangrene may be local or spreading. In the form case it may arise from the actual crushing, even when the fracture is a simple on or from thrombosis, rupture of the main vessels, or tight bandaging; but whatev the reason, if an attempt has been made to save the limb, and it is plainly becom ing colder, amputation should be performed at once. The most difficult cases ar those which hang in the balance for a day or two, sometimes warmer, sometime colder, before it is possible to be certain.

Spreading traumatic gangrene may result solely from the defective nutrition of the tissues—the vitality of the part is so low from renal disease, diabetes, cold, exposure, or other causes, that the structures perish even if they are only bruised—or much more frequently from the action of irritants that make their appearance subsequently in the wound. Septic decomposition, high tension and suppuration acting together cause the most fearful form. Putrefaction takes place in the

wound; the poisons produced are driven by the tension into the cellular interspaces, destroying everything they touch, and the microörganisms of suppuration complete the destruction. Hospital gangrene, which was the worst form ever known, was simply the product of these agents acting under peculiarly favorable conditions.

*Solid Œdema.*—Solid œdema, due to lymphatic and venous obstruction, is often present after fractures, especially compound ones, in which there has been inflammation or sloughing of the cellular tissues. The nutrition of the whole limb suffers; it remains cold and hard; the skin is tightly bound down to the parts beneath; ulcers are liable to form, and though they may be cured by attention to position and rest in bed, they invariably break out again as soon as the limb is used. In one case I removed a leg, at the patient's request, seven years after a severe compound fracture, in which resection had been performed; the ulcer, which was exceedingly painful, had broken out nine times, and he had spent more than four years of the seven in bed.

*Muscular Atrophy.*—Muscular atrophy is present in most cases of fracture. If it is merely the result of inactivity, recovery is, generally speaking, rapid and easy; but sometimes, when the limb has been severely crushed, or when there has been much inflammation, the fibres are so matted together, and the tendons so crippled by adhesions, that the process is very tedious. In other cases there are special reasons for it; the lower part of the vastus internus, for example, never quite regains its size after fracture of the patella. According to Volkmann, paralysis and contracture are sometimes caused by the prolonged constriction of the blood-vessels; the muscles become stiff and hard; all control over them is lost; and movement becomes intensely painful. It is said that this is due to the breaking up of the contractile substance in consequence of the deficient supply of blood. In other cases again, shortening, sometimes of a very obstinate description, is brought on through malposition during treatment.

*Ankylosis.*—Stiffness of the joints is very common even when they have escaped direct injury. Bonnet and others have described very extensive alterations as taking place in them merely from prolonged rest, the cartilage disappearing, and the opposing surfaces becoming united by dense, fibrous tissue. Such changes, however, occurring independently of inflammation, are very rare. As a rule, the joint becomes stiff because passive motion is not resorted to sufficiently early; the capsule becomes rigid; the amount of synovia is deficient; the soft tissues around grow hard and thick; and the folds and fringes become adherent to each other, and no longer accommodate themselves to the changes in pressure as the bones are moved. The tissues, in short, are so badly nourished that they are unable to do their share of work.

Residual abscesses occasionally make their appearance in compound fractures many years after the original accident, and sometimes minute sequestra are found inside them; in some cases, perhaps, they are small fragments that have been locked in during the process of repair. Atrophy of the bone has also been known to follow without apparent reason, and cases of malignant disease starting from the seat of injury are not so uncommon as might be expected.

### Treatment (Immediate).

In every case of fracture the first thing is to prevent further injury. The limb must be placed in a suitable position; the clothes removed, always beginning with the sound side, and where it is necessary, slitting up the seams; and the injured part thoroughly exposed. A small wound is better sealed at once; dried blood-clot is an excellent protection; if it is large, means must be taken to check the hemorrhage before anything else. Then the limb must be secured so that the patient may be moved with the least amount of risk.

In fractures of the upper extremity there is no difficulty; the arm can be bound to the side of the body with one handkerchief, and the hand and wrist

supported with another tied round the neck to form a sling. In the case of the leg and thigh, however, some form of splint must be extemporized. It may be made out of almost anything: laths or wood, bundles of straw, rolls of newspaper, umbrellas, or whatever else is to be had at the moment; the only requirement is that it should be sufficiently long and rigid to keep the limb steady in the most comfortable position. A broken leg should be laid on its outer side with the knee and hip flexed; the thigh may either be placed in the same position, or the two limbs may be tied together and secured to a splint made out of a broomstick with some cloths round it, long enough to reach from the armpit to below the knee. Only in the case of the spine and pelvis nothing of the kind should be attempted; the patient is merely to be placed perfectly straight in the recumbent position until he can be lifted on to a stretcher.

To raise an adult with a broken leg comfortably, at least three persons are necessary: one to take charge of the limb, the others one on each side, facing each other, with their hands well beneath the hips and shoulders; the stretcher should be placed at the patient's head, as it is more easy to lift him over the end. Bearers should be cautioned against keeping step, and if the lower extremity is broken, care must be taken that the shoulders are not raised higher than the feet.

A fracture bed should be narrow, so that the patient may be reached from either side, firm and elastic without being soft, and if the spine or the upper part of the leg is involved, so arranged that nothing is disturbed when the bowels act. Woven wire mattresses with a hair one on the top are the best; sinking at the hip may be prevented by a board underneath extending from side to side. In injuries of the spine, and in any case in an old person, water-cushions under the pelvis are essential. Very many contrivances have been devised for the use of the bed-pan: one of the best is a circular opening in the mattress protected round the edges with oiled silk, immediately under the nates; this is filled up from beneath with a cushion which, when occasion requires, can be lowered by means of a screw attached to the side of the bed and replaced by the pan. Two sheets, of course, must be used, folded double, one beneath the shoulders, the other at the lower end of the bed, the folded margins meeting over the opening. In other cases a conical wedge of the mattress may be made to slide in and out from the side. Or the opposite plan may be adopted: a very stout piece of canvas, perforated in the centre, is laid over the mattress and fastened all round to a strong wooden frame, a little smaller than the bed itself. When it is not in use, this rests upon the framework of the bed; but it is so contrived that when the pan is required it can be raised with screws or pulleys six inches or so from the mattress with the patient lying on it.

The same precautions must be taken in lifting the patient on to the bed; then the clothes must be removed, the skin thoroughly washed and dried, all temporary appliances taken away, and the limb either secured with sand-bags or laid upon a pillow lengthwise and tied up in it.

### Treatment (Permanent).

Fractures should in all cases be set as soon as possible; the only exception is when the swelling and tension are already so extreme as to threaten gangrene. If there is the least danger of such a complication, it is better to avoid manipulation, and merely to raise the limb and place it in a comfortable position, secured by sand-bags or tied up in a pillow. In other circumstances there is nothing to be gained by waiting, or by the application of cooling lotions; the difficulty increases every hour; the swelling becomes greater and greater; the muscles, which at first are relaxed, grow more and more rigid; and there is always the risk that by some incautious movement the injury may be made a great deal worse.

### 1. *Reduction of the Fracture.*

The first thing is to disengage the fragments and restore them to their proper position. If they are impacted, and it is considered advisable to separate them, a certain amount of force must be used, and where a bone is only partly broken, as in greenstick fractures, it is generally impossible to restore the shape without considerable pressure, sometimes even making the fracture complete; but in all ordinary cases, where the displacement is due either to the weight of the part or to muscular contraction, the less force that is used the better. Gravity must be counterbalanced by arranging the patient so that it assists in the reduction of the deformity, instead of being a source of difficulty, and the muscles must in some way or other be induced to relax.

(*a*) *Anæsthetics.*—In many cases an anæsthetic is essential. The rigidity disappears at once, the limb can be thoroughly examined without causing pain, and if the bone is set immediately, before consciousness is restored, while the muscles are still at rest, the spasmodic contraction does not return. The only objection is that, particularly in men who are accustomed to a large amount of stimulants, and whose struggles are sometimes very violent, the injured limb may be seriously hurt unless it is very firmly held. Where gas and ether are used the risk is not nearly so great.

(*b*) *Tenotomy.*—Tenotomy may be employed when one muscle in particular is in fault. The tendo-Achillis, for example, may be divided when there is obstinate spasm of the gastrocnemius, or when the lower end of the femur is detached from the shaft and rotated backward, so that it is in danger of pressing upon the popliteal artery or vein, but it is seldom required in other cases.

(*c*) *Position.*—It is of the utmost importance to place the limb in a position that will secure the maximum degree of muscular relaxation. In Pott's fracture, for instance, the knee is flexed to prevent displacement of the foot by the gastrocnemius; and when the femur is broken immediately below the trochanter, the whole limb is placed upon an inclined plane if the upper fragment is raised to any degree by the ilio-psoas. The opposite muscles are stretched, it is true, but in most of the cases their action upon the fragments is insignificant in comparison, and unless they are irritated by the broken ends and made to contract, they generally yield without trouble.

(*d*) *Extension.*—When the deformity cannot be reduced in this way, extension and counter-extension must be employed, either for the time only, until the limb is secured by a splint, or during the whole period of treatment. In temporary extension one part (generally speaking that nearer the trunk) is held by an assistant, the other is grasped by the surgeon, and steady traction made in the axis of the limb until the fragments are unlocked and the length and shape restored. Often it is necessary to sway the part gently from side to side, or to rotate it a little so as to disengage the ends, and sometimes it is better for the extension to be made by the assistant, while the surgeon manipulates the part himself; in any case the pull must be absolutely steady and continuous, without violent movement or jerking of any kind. When a sufficiently good hold can be obtained, the grasp should be made on the ends of the fractured bone, and the interposition of a joint avoided; the soft parts are not so liable to be injured, but the rule is not absolute. In fractures of the femur, for example, extension must be made from the leg and counter-extension fromthe pelvis; and when the leg is broken it is very much better to use a slight degree of extension with the knee flexed (so as to relax the muscles of the calf) than to pull it into position by main force.

The amount of force used and the extent to which manipulation is carried must be left to the discretion of the surgeon. In some cases the fragments are too firmly impacted to be separated; in others a splinter is so far displaced from its normal situation that it cannot be restored; or again, the sharp-pointed ends have been pushed so far into the soft parts by the contraction of the muscles, that it is impossible to disengage them g them into apposition. So long as the

fracture is a simple one, it is better to leave these alone, in spite of the prospect of deformity, and the possibility in the last mentioned case of failure of union, than to run the risk of inflicting even greater injury on the patient. If the fracture is already compound, the question, of course, is entirely different.

Continuous extension is required for those cases in which the displacement is maintained by muscular contraction, as in fractures of the thigh. If the femur is broken obliquely, especially in an adult, it is only possible to restore the limb to its normal length by placing the patient under an anæsthetic, or tiring the muscles out. Extension for a time only is of little or no use, but, if it is kept up steadily and continuously, even though the force is only slight, the contraction gradually gives way, and the limb regains, or nearly regains, its normal length.

### 2. *Prevention of Return of Displacement.*

As soon as the deformity is rectified and broken ends adjusted, the part must be secured against displacement a second time. The same forces are still acting; however quiet the patient may lie, it is impossible to avoid involuntary movements, the influence of gravity is always at work, tending to displace one fragment from another, and, even when there is no spasmodic contraction, the muscles cannot help growing shorter and shorter when the rigid framework is once broken.

The means used to prevent this depend chiefly upon the degree and nature of the deformity. In fractures of the bones of the face, for example (the lower jaw excepted), the tendency to displacement is so slight that, if the fragments can be restored to their proper situation, little more than protection is required; and where one bone in a series has given way, a rib, for instance, or one of the metacarpals, a bandage is, generally speaking, sufficient. Even if there is only a pair, as in the leg, the uninjured one nearly always prevents any serious degree of displacement. On the other hand, in fracture of the bones of the extremities, where the muscles are very powerful, and the deformity often exceedingly difficult to rectify, it is rarely possible to keep the broken ends in apposition without the aid of bandages and splints.

*Bandages.*—Roller and triangular bandages are the ones in common use, though many other varieties are employed in special cases. The former answer best where firm and continued pressure is required, and are made of unbleached calico torn in strips, from four to six yards long, and two to four inches wide, or of flannel, domette, or other loosely woven material, according to the nature of the case and the amount of yielding desired. The latter are most easily made from a square yard of calico cut in two diagonally, and are chiefly of use for retaining dressings in position and as slings for the support of the arm or hand.

*Splints.*—Splints may be made of almost anything, but invariably the simpler they are, the better. Their object is to keep the broken ends in thorough apposition and at perfect rest; they must, therefore, fit the limb accurately; they must be well padded, so that the pressure is uniform, and does not fall too heavily on the bony prominences or the injured part; they must, as far as possible, fix the neighboring joints; they must be arranged so that, at any rate at first, the seat of fracture can be easily examined, and they must not interfere with the circulation. Bandages, or webbing straps and buckles, are used to secure them round the limb. No constricting band should ever be applied directly to the limb beneath. The circulation is already impeded by the swelling and extravasation; the veins are compressed more than the arteries, owing to the thinness of their walls; blood continues to pour into the part, without being able to return, and, if there is an unyielding bandage round the limb, strangulation and gangrene are very likely to follow. For the same reason, when a single, flat splint is used, however well it is padded, it should never be secured to a fractured limb with strapping. Below the seat of injury, there is not the same objection. When the humerus is broken, for example, a bandage may be applied with advantage to the hand and forearm, to prevent the passive œdema and swelling that are caused by the obstruc-

; but even then it is advisable to leave the tips of the fingers exposed, so that e may be no doubt as to the condition of the circulation.

Ordinary pads are much too hard, especially when made with tow; they ought e sufficiently soft to press evenly on all the surface of a limb, and not harshly ny part. Absorbent cotton-wool, folded in sheets, answers best.

*Movable Splints.*—The simplest splints are made from soft, light wood, gen- ly deal, as it can be worked easily. If they are flat, they should be a little er than the limb, to take off the pressure, but it is more comfortable to have n hollowed out, especially opposite bony projections, and beveled at the edges. ers are of metal, sometimes perforated on account of the weight. They may trough-shaped, rigid, and provided with hinges to allow a limited range of vement, or made of some flexible material, such as zinc, or woven wire, so as fit into all the curves of the part. Where strength is not of importance, as in : upper limb, and in the case of children, lighter materials are used, pasteboard, tta-percha, or, what is much better, as it is porous and weighs less, felt steeped resin, so that it becomes hard when cool. The two last are especially useful, as warming they can be readily moulded to fit any part, and felt splints can be tained in sizes, roughly shaped already, so that a very slight degree of modeling required.

*Immovable Splints.*—Other kinds are made by surrounding the limb with a oven material, such as muslin, calico, or flannel, and saturating this with sub- ances which set, or become hard when they dry. Starch-paste was one of the st employed. The limb is enclosed in a thick layer of cotton-wool, over this re placed longitudinal strips of torn pasteboard soaked in starch, so close gether that only a small space is left between, and these are bound together with yer after layer of bandages saturated with the paste, as many as may be required. ometimes, strips of tin are inserted opposite the joints to give additional rigidity. Then, the limb is fixed on a splint until the starch is dry. In this way a firm and ven casing is obtained, but the process of hardening is very tedious, even when he temperature is maintained; the outer layers dry first, and prevent evaporation rom those beneath, so that, where special thickness is required, it may be some lays before the splint is thoroughly firm.

Plaster-of-Paris is free from this objection. The ordinary bandages are made f a coarse, crinoline muslin, and may be kept in a tin case ready for use. The owder is rubbed into their meshes while they are being rolled, and they only re- uire to be placed upright in water for a minute or two, until the bubbles of air ave escaped. A flannel bandage is put on first; cotton-wool does not answer so ell, as it is very difficult to keep it sufficiently smooth; and then the prepared andages are rolled round the limb, without employing any pressure or making ny reverses. Generally speaking, two layers are enough, some loose powder eing rubbed in between them, and a little more, with plenty of water, over the urface of the last. Strips of tin may be employed, as with starch, and, especially or children, the splint may be made waterproof with paraffin. The setting of the laster can be delayed by adding mucilage or borax to the water, and accelerated o some extent by alum; but, if there is any doubt as to the freshness of the owder, it should be rebaked.

For many purposes, plaster splints can be made more conveniently with absor- ent cotton-wool, as recommended by Gamgee. The limb must be first invested ith a sheet of wool, and then strips of the same material, cut to shape, are dipped n plaster and water, the consistence of cream (made by sprinkling the powder nto a basin of water, stirring all the while), and fastened round with absorbent andages. As soon as it is set, these are cut, and the shells lined with the first ayer fall apart from the limb.

Gum and chalk—powdered chalk rubbed down with mucilage, until it is the consistence of thick gruel—answers better in some cases. It does not dry so quickly, it is true, but it is lighter, firmer, less apt to crack and crumble at the edges, and is more elastic. A flannel bandage is applied first, then an ordinary

calico one, into which the mixture is well rubbe the whole is given a final coating, and it is then

Silicate of soda, of the consistence of syrup it is better to roll the bandages in the solution, a It dries rather more quickly.

Tripolith differs very little in its uses from vantage of being rather lighter, and of not softer ened after it has once set. It is said, too, to set a great deal upon the amount of water with whic

Paraffin is rarely employed. The most cor strips of cotton-wool in the melted fluid, in the and, when sufficiently cool, to mould them to the with a bandage and allowed to harden. A ver taken in this way, but it is not so rigid as plaste the paraffin is one that only melts at a high temp from the heat of the body.

Care must be taken to keep the limb well rai as most of them contract a little during the pr always be left exposed, in order to judge the the fingers or toes look blue, or become cold ar not return immediately when driven from the ma the splint must be slit and removed at once. In r more imperative; swelling sometimes sets in ve tion is not relieved, the circulation may be stop and gangrene be caused in a few hours.

After they have been on some time the oppo the splints become too loose from absorption of the muscles.

[This, indeed, is one of the most serious obj tion of immovable splints, for it is obvious th splint, at first accurately fitting, becomes loose fragments is allowed, with sometimes very bad re

*Movable* v. *Immovable*.—There is no doubt admirably suited to fractures that have already u whether it is wise to apply them while the injury subsided and the danger of inflammation is past. fection; they do not require to be readjusted as or displacement is hardly possible; the uniform and lessens the tendency to swelling and œdema earlier than he otherwise would; and the risk avoided. In short, they answer every requisite allow the seat of injury to be inspected; the wh anything were to happen gangrene might occur b as in such cases pain is sometimes conspicuously

In fractures of the femur it does not answer, except in the transverse ones of nts and children. Longitudinal displacement is too easy, and the bony points not sufficiently marked. These must be left three or four weeks, until there is ertain amount of consolidation and the tendency to shortening is lessened. In : leg, it is more suitable so far as the limb is concerned; the foot and the knee a be easily secured, while the hip cannot; the bone is not so thickly covered, d the muscular contraction is more easily controlled; but the question does not t on this altogether. The condition of the skin, and the extent to which the t parts are injured, are more important. If the fracture is comminuted, and ne time has passed since the accident, so that already there is a great deal of ex- vasation; if a big vessel has given way; if the skin and the subjacent tissues are dly bruised, and it is doubtful if they can live; or if there is any danger of the cture becoming compound,—it is better to take the leg entirely out of the tient's control by means of a swing and the ordinary back and side splints. ith such an injury, confinement to bed for several weeks is absolutely necessary, atever appliance the patient wears. It is not necessary to sacrifice the benefits uniform compression over the whole surface; the blebs, which often form the rting-point for inflammation, and are never found under splints, but always at eir edges, can be prevented equally well by using a sufficient amount of absor- nt cotton-wool in addition to and between the splints; but these must be ranged so that it is possible to examine the injured part as often as may be shed, without disturbing one of them or relaxing the grasp on the limb.

In other cases, when, for example, the bone is broken transversely and there not much displacement, when only one of a pair has given way, and when e structures around are but little hurt, this plan should be adopted from the st.

### Treatment of Fractures that are Compound by Indirect Violence.

The treatment of open fractures is guided by the nature and extent of e injury inflicted on the surrounding structures. When the skin is merely punc- red from beneath by the sharp end of a broken bone, no plan is more successful an that advocated by Astley Cooper. If the opening is already closed by a clot, ery effort must be made to preserve it; but if blood is still oozing out or if e wound is unavoidably reopened by the manipulation necessary to reduce the acture the skin around is to be thoroughly cleansed with antiseptics (corrosive blimate 1 in 500, or carbolic acid 1 in 20), the edges carefully adjusted, iodoform wder dusted in, and then a soft absorbent pad of wood-wool or prepared moss id over it. Sometimes, especially in the leg, the bone is still protruding, tightly asped by the skin; and occasionally there is some little difficulty in reducing it, en when the patient is under an anæsthetic. The opening may then be slightly nlarged and a further attempt made; if this is unsuccessful, particularly if it is a ng, pointed spine that is likely to give trouble afterward, or if the periosteum has een stripped back from it, it is better to cut it off at once with bone forceps. he wound should then be thoroughly washed out and treated in the same way. ven if there is comminution, or if the fracture extends into a neighboring joint, his plan in actual practice gives results that have not been surpassed.

In all compound fractures, except in the case of the smallest bones, the patient should be confined to bed until it can be seen what course events are likely to take. If the wound is only a puncture, a fixed apparatus may be applied at once; but the splint must be arranged so that the dressing can be easily removed. Either a window must be cut, or, what is better, an opening left while the splint is being applied; and to prevent the tissues becoming œdematous and projecting outward through this, a small but firm pad should be fitted into it. If the temperature rises, the dressing must be removed at once.

In all other cases interrupted splints are used, the pads being covered with oiled silk, and so arranged as to interfere with drainage as little as possible. Fixed

apparatus should be reserved until the bones are beginning to unite and any wo that is present has healed.

### Treatment of Fractures that are Compound by Direct Violence.

In fractures by direct violence where the soft parts are crushed, the bone pe haps comminuted, and the skin torn and lacerated, the question is different.

The first thing to decide is whether the injury is consistent with life. many cases, such as railway accidents in which both thighs have been crushed, th shock is so great that the patient never rallies, and any attempt at operating mere precipitates the end; or other injuries of an even more serious description inflicted at the same time. In such as these, all that can be done is to preve hemorrhage (even capillary oozing is serious) and check the tendency to putrefa tion, which is particularly prone to occur in the region of the bone. Arteri rarely bleed under these conditions, but if they do, or the veins, they should b tied or clamped; then the wound must be thoroughly washed out with a solutio of corrosive sublimate as hot as can be borne, and wrapped in an absorbent dre ing. Loose clots may be allowed to float away; others should be left untouched Hemorrhage from the bone, which is often very persistent, must be stopped b elevation or pressure.

Meanwhile, every effort must be made to tide the patient over the shock; the blankets must be warmed, hot bottles placed all round the body, the limbs ban daged, and stimulants, brandy and ammonia, administered freely, or even injected under the skin. If reaction definitely sets in, and the temperature begins to rise, it becomes a question whether amputation should be performed at once, or an attempt made to save the limb.

#### 1. *Amputation.*

(*a*) *The Patient.*—The age and constitution of the patient are the first things to be considered. In children much more may be attempted than in adults; their tissues heal more readily, and they have no anxieties; but in sound old age the power of recovery is often surprisingly good. The condition of the viscera, particularly of the kidneys, is of greater importance. Sloughing and diffuse inflammation are almost sure to occur, if the urine is albuminous or the specific gravity persistently low. The vitality of the tissues, if they are crushed or bruised, is too feeble to resist, and the only chance of life lies in the complete removal of all the damaged part. Even when no change in the secreting power of the kidneys can be directly proved, it is distinctly unfavorable if the aspect of the patient is such as to suggest over-indulgence either in food or drink.

(*b*) *The Injury.*—The locality of the injury and the complications that are present, as a rule, are final.

*The Upper Extremity.*—In the hand and forearm the part must be almost disorganized to justify amputation. The wrist joint may be opened, the carpal bones crushed, and the hand cut to pieces, without such an extreme measure being necessary, if only a single movable finger is likely to be left. I have known such injuries as this treated with corrosive sublimate baths for an hour each day recover witho a single febrile symptom. If, however, the large nerve-trunks are injured beyo repair, or if the skin is torn off round the whole circumference for even a sho distance, the limb never recovers so as to be of any use. In the former case remains cold and helpless, often ulcerated or the seat of severe pain; in the latter it swells up to such a size from solid œdema and becomes so hard and stiff that i is merely a useless log.

The extent of the injury to the soft parts is equally decisive in the case of the arm or elbow. The artery may be wounded, the joint laid open, and the ends of the bone badly comminuted, and yet the vessel may be tied, the fragments of bone removed, and an informal kind of excision performed with an excellent result, so far as utility is concerned, if only the surrounding structures are not too

ly bruised. Unhappily, such accidents generally occur from direct violence, d then the skin is stripped up, the muscles are torn and bruised, and everything crushed to such an extent that no alternative is possible.

*The Lower Extremity.*—Amputation is more frequently required in compound ctures of the lower limb. The circulation is not so active as it is in the upper, pair is not carried on with the same degree of energy, there is a greater risk of ngrene and of diffuse inflammation, the joints are larger and more complex, and e need for stability is much greater.

In the case of the foot, for example, everything must be sacrificed to gain a rm support. In the hand it is a rule never to remove anything that can by any ssibility recover; a fragment of a thumb is infinitely more useful than an artifial one; in the foot free removal is often the better plan. Yet even here much ay be done sometimes by judicious conservatism. In a case under my care, in hich the contents of a gun had passed completely through the foot, so that an pening was left into which three fingers could have been placed, recovery was so erfect that the patient could walk three or four miles without inconvenience six months after the accident. The bases of the first two metatarsal bones with the corresponding portions of the internal and middle cuneiform were blown completely away; but the external plantar artery in all probability remained intact and the tread of the sole was uninjured.

When there is a compound fracture of the leg, the question is generally decided by the condition of the soft parts, especially the skin and the blood-vessels. The ankle joint may be opened and the bones comminuted, but so long as the circulation is good, and the skin is not destroyed, a very useful limb may be obtained by resetting the broken ends and removing splinters that are loosened too much to live. Similar injuries in the case of the knee joint are much more serious; compound fractures of the patella only may be treated in this way with a fair prospect of success, even though the cavity of the joint is widely opened; but when the lower end of the femur or the upper end of the tibia is badly comminuted, the injury is, generally speaking, too severe. Even here, however, primary resection has been performed with success in the case of gunshot wounds.

Compound fractures of the femur are still more serious. If they are caused by direct violence the injury is almost hopeless so far as the limb is concerned. Very often it is much worse than at first sight it appears to be; the muscles are torn and crushed so that they protrude from their sheaths; the deep planes of areolar tissue are laid open, and the skin stripped up from the fascia beneath and bruised beyond recovery for a distance above the seat of injury almost equal to the diameter of the part.

When the injury involves the upper part of the thigh or the hip joint, the shock is nearly always fatal; and even if the patient rallies it is very questionable whether primary amputation in the upper third or disarticulation should be performed. It is true that there are a few successful cases on record; but certainly in gunshot wounds, if the head of the bone is shattered, better results are obtained by removing the fragments, securing perfect drainage, and amputating later, when the period of acute suppuration is past. Probably in the majority of those instances in which the patient does rally sufficiently, the best chance lies in merely removing the part that is injured (for which Paquelin's cautery is of excellent service), leaving the wound open, and by means of antiseptics and drainage, limiting the amount of septic absorption as much as possible. Even in other parts of the body this plan may sometimes be followed with advantage; it is true there is usually a large amount of suppuration, but the shock is not nearly so great as when a formal amputation is performed, and owing to the nature of the wound the amount of septic absorption is much less than might be expected.

### 2. *Preservation.*

If it is determined to try and save the part the fracture must be reduced the same general principles of treatment followed, interrupted splints and covered with oiled silk being used. The presence of a wound, however, more or less serious injury to the other structures in the limb—muscles, cellular tissue, etc.—necessitates something more.

*Hemorrhage* must be checked at once. The limb must be raised, all striction removed, the main artery, if necessary, placed under control, all clots washed away, and any bleeding point secured. General oozing is checke washing out the wound with an antiseptic solution (tincture of iodine or co sive sublimate) as hot as can be borne, and applying gentle pressure afterward

*Splinters* that are quite loose and detached should be removed, and if the of the bone cannot be readjusted, especially if they are stripped of their pe teum, they may be resected. Large fragments that are firmly adherent shoul left. An exception may be made in the case of gunshot wounds caused by jectiles of high velocity; in these it has recently been shown that, if a comme ment is once made, it is very difficult to stop; removing one fragment seem loosen all the rest, so that if the drainage is good it is better to leave them un certain amount of consolidation has taken place. If much is removed care be taken to bring the broken ends well together, or union may fail.

*The wound* must be thoroughly cleansed, so that no poisonous material form, and thoroughly drained, so that if it does it may escape externally, and be absorbed. The principles on which this is to be done are easily laid do the details vary naturally with each case.

The skin for some distance around must be cleansed with turpentine and strong solution (1 in 500) of corrosive sublimate. All dirt must be picked o if it is so much ground in it that it is impossible, the tissue should be cut aw unless it is skin. The dirt is always on the outside of this, and it can be render inert without destroying the whole thickness and endangering cicatrization.

If the wound is foul, or such that it cannot be sealed at once, it must cleared of all foreign matter and blood-clot, and washed out with an antisept using a rubber drainage-tube or a catheter to conduct the fluid into all the recess At the same time, care must be taken to make the opening sufficiently free, and necessary to make others, so that the fluid is not retained and absorbed. Immed ately after an injury of this kind, when the planes of fascia are torn across different levels, and all the lymphatic spaces are gaping widely, a poisonous amou can easily get into the circulation, and either cause local sloughing or lead t constitutional symptoms.

Tincture of iodine (1 in 80), carbolic acid (1 in 40), or corrosive sublima (1 in 1000) are the most used; the last is the most effectual, but at the same tim the most dangerous if retained. If there is any capillary oozing they should b injected at a temperature of 120° to 140° F., so as to leave the wound thoroughly dry; it is of great importance to reduce the amount of discharge as much possible, and keep the cavity free from any putrescible matter. With this object Gamgee recommended equal parts of spirit and water, or a saturated solution of borax with about one-eighth of its bulk of glycerine, in preference to the watery solution of any antiseptic.

After this iodoform may be dusted lightly over the surface. It is true th grave doubt has been thrown on its merits as a germicide, and that in some i stances, when too much has been used or the patient has been peculiarly susceptib serious symptoms have followed its employment, but there can be no question th in some way it possesses the power of limiting the amount of exudation and d couraging decomposition.

As soon as everything is satisfactory, the deeper parts must be brought in the best apposition possible, buried sutures of catgut being used, if necessary, bo in the bones themselves and in the dense sheets of fascia. If the wound were

le incised one this would be enough, but it is always irregular in shape; the es are badly bruised and crushed, not cut, and the necessary cleansing and ntiseptics injure them still more. As a result, a large amount of fluid is sure ollect; absorption, even when aided by pressure, cannot keep pace with lation, and unless free exit is provided tension and inflammation must follow. here is a dependent opening, perfectly straight and wide, it may be left, with bsorbent dressing properly arranged (that is to say, a piece of protective , as large as the wound), and all the fluid will be sucked out; but such a con- on is rare in a compound fracture. Almost always the internal wound is very e, and the external very small, and at the top, or at least very rarely at the tom.

Under these circumstances counter-openings must be made wherever there is least indication (and advantage may be taken of these to get rid of as much he extravasated blood as possible), drainage-tubes of sufficient size must be rted, and the edges of the skin wound must be left widely open, sutures only g used to retain torn flaps in position.

All the points at which fluid can exude should be covered with waterproof or ective to prevent the dressing sticking to the surface and becoming clogged. more absorbent the material used to envelop the part the better. Wood-wool prepared moss are some of the best; Lister's gauze, owing, in a measure, to resinous substance with which it is impregnated, takes up too little, and rbent cotton-wool by itself is apt to cake if there is much discharge. Decom- tion of the exudation can hardly take place in the dressings, owing to its con- ration, and it may be rendered impossible by having the material prepared some non-volatile antiseptic.

If this has been successful the dressing may be left untouched for two or e weeks. Drainage-tubes, however, cannot remain so long; as a rule, they t be removed by the third day, as they are very liable to become plugged coagula and rendered useless. After this the longer the second dressing is poned the better. Every time the fracture is touched it gives pain, causes ation, and delays repair. The wound, if the treatment is carried out thor- ly, and the patient's tissues are fairly sound, fills up from the bottom, and n at length it is exposed, it is either already skinned over, or else is level with surrounding surface, perfectly smooth, pale, and, perhaps, just moistened by a e of pus.

Inflammation, the result of continued irritation (whether by tension, want of foreign substance, or decomposition), has been successfully prevented.

In many cases, especially where the foot and hand are concerned, or where a is involved, or where from any other cause the prospect of limiting the unt of exudation is doubtful, the whole part may be immersed in a bath. etimes, when a hand is crushed, it is impossible to tell what will live and what not; more than is necessary may be cut away, or, on the other hand, some that is already dead and beginning to slough may be left. Such cases may laced in a warm bath of corrosive sublimate and left with perfect safety, ays provided the whole cavity of the wound is laid open. If this is not done, efaction may still go on in the interior. I have known this happen in a com- nd dislocation of the wrist; a large cavity filled with extravasated blood was looked under the deep palmar fascia, and putrefaction and suppuration con- ued unchecked, although the hand was kept in a continuous bath; the fluid er penetrated into it.

If the bath is continuous, one part in ten thousand is sufficient; if it is only d for an hour or two in the course of the day, it should be at least one in a usand; and a few drops of hydrochloric acid or ammonium chloride should be ded. Careful watch must, of course, be kept upon the patient's teeth, and if re is any diarrhœa, the corrosive sublimate should be stopped at once and ucic acid substituted; but though I have treated many cases in this way, I have ver known any serious consequence of this kind result. The limb should be

xhaustion and fever sleeps well the following night, and re-
ıoment. Sometimes, however, it must be done at once; it
ce of saving a life threatened by absorption from an inflamed
ɔus limb. The condition may appear to be desperate, but the
whole source of the poison is the only thing left, and occa-
the flaps are sodden and œdematous, and the pulse too quick
eets with surprising success.

### Compound Fractures into Joints.

must be carried out on exactly the same plan, only it must be
w, no matter how small the wound of the skin may be, its real
e the size of the synovial membrane. If there is only a punc-
times produced by a splinter of bone), and the opening does
r if it is merely a clean incision, an attempt may be made to
ady described, and prevent inflammation by cold, eleva-
er means that may be available; but careful watch must
ition of the joint and the temperature of the patient, so
ot set in unawares. If it does, the only hope lies in free
rainage. In all other cases, especially where the force is
aps torn or ground in with dirt, it is better to enlarge the
t the joint thoroughly with corrosive sublimate solution
dily in a bath), and make counter-openings for drainage
nce of any pocket forming. The question as to the ad-
amputation must be determined in each case, partly by
patient, partly by the amount of injury; if the bone is
d, but the skin fairly sound, and the circulation not seriously
y excision may be attended with the greatest success, even
under other circumstances (except in the case of the hip)
only chance.

ons that occur in the course of treatment of fractures must
mselves. Injuries to important viscera, such as the lungs,
ideration; cellulitis, erysipelas, pyæmia, and other forms of
are described elsewhere. Abscesses may have to be opened
ed years after the original accident; passive motion and the
dhesions are often required before it is possible to make use of
s; massage and galvanism may be needed to restore strength
tion and bandaging may be necessary to relieve the obstinate
ıes follows, and to prevent ulceration; and even amputation
r all; either the limb is useless and the seat of constant pain,
mount of suppuration that the patient is in danger of sinking
austion.

## TURE OF THE BONES OF THE FACE.

### The Nasal Bones.

s often suffer from direct violence; the fracture may be com-
ally, internally, or both, or it may be comminuted, and the
d to the bones themselves, or the septum may be bent or
er bones that surround the nasal cavities may be involved as
the greater part of the cribriform plate of the ethmoid com-
in splinters through an opening in the nose, so that the
visible.

ys profuse; emphysema is occasionally present from the
ues, and deformity and swelling are generally very con-
uld be spared to effect reduction as early as possible.

adults in four or five; but the arm should be carried in a sling for a week or longer. If there is any rigidity about the shoulder-joint afterward, the limb must be worked while the patient is under an anæsthetic.

Ellis's splint consists of a well-padded short crutch, which is pressed up into the axilla by a strap carried over the opposite shoulder, and of a band, embracing the arm, passing through two slits in the crutch, and then surrounding the thorax. The head and elbow are supported by a sling in the ordinary way.

Sayre makes use of strapping spread on moleskin without any axillary pad. Two pieces are required, each three and a half inches wide. The first is secured loosely in a loop round the humerus (the non-adhesive side next the skin) just below the axilla, and then carried behind the back round the chest until the circle is completed; this draws the shoulder back and acts as a fulcrum. Then, while an assistant brings the elbow forward and pushes it up, a second strip is carried from the opposite shoulder, obliquely across the first, under the point of the elbow (which fits into a slit cut to receive it), and under the forearm as it lies upon the chest, up to the point from which it started. The theory is that when the elbow is forced upward and forward in this manner, the shoulder, owing to the way it is held, is driven outward and backward, in this way correcting the tendency to displacement inward and forward; but, though this plan succeeds fairly well in ordinary cases, it is doubtful how far it is due to the leverage (Figs. 120, 121, 122).

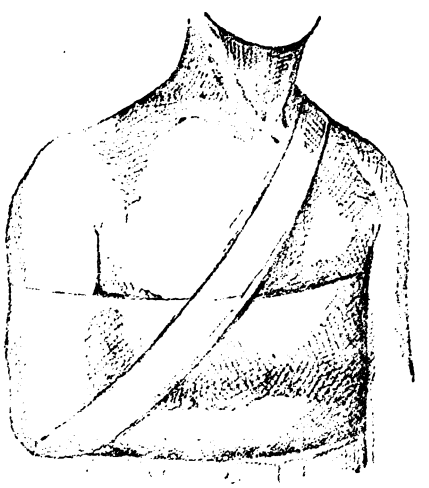


FIG. 123.—Pick's Quadrangular Bandage Arranged as Sling for Arm.

The figure-of-eight bandage is practically abandoned; it is exceedingly uncomfortable, very insecure, and tends to depress still further the outer fragment. Pick's four-tailed bandage is very useful in the case of children. It is made of a stout piece of calico, long enough to go more than round the body, and (for an adult) fourteen inches wide. This is slit up from either end to within six inches of the middle, but one tail on each side is four inches wide and the other ten. An axillary pad is adjusted; the patient is placed in the recumbent position, with his arm by his side, and the forearm flexed across the chest; and then the bandage is arranged so that the point of the elbow is opposite the untorn strip in the middle (a vertical slit may be made in it here for the purpose of supporting the joint), and the broad ends surround the arm and the chest. These secure the arm to the side, and then the narrow ones are brought up from under the elbow, and tied over the opposite shoulder. This bandage has the very great merit of being much less easily disarranged than most of the others (Fig. 123).

*Compound fractures* of the clavicle are nearly always the result of direct violence, and may be either comminuted or complicated by the presence of injuries to other structures near. In one or two cases the fragments have been wired together.

*Ununited fracture* is very unusual, even when the deformity is very great and the part is not kept properly at rest. The loss of power to the arm is by no means so marked as might be expected.

## FRACTURE OF THE SCAPULA.

*Fracture of the scapula* may involve the body, the acromion, the surgical neck, or the coracoid process. Fracture of the anatomical neck (leaving the coracoid on the body of the bone and detaching the glenoid fossa only) is doubtful

sometimes, in dislocations of the humerus, portions of the margin are chipped off (Fig. 124).

*Fractures of the body* scarcely ever occur except from direct violence; they may be single, stellate, or comminuted, and may traverse the spine or not. The signs are usually distinct, though, owing to the dense fascia, and to the muscles attached to both surfaces of the bone, displacement is rarely considerable, and it is difficult to obtain distinct crepitus. Pain, swelling, and loss of power are always present.

A firm pad must be moulded on to the scapula to retain it in position by direct pressure, and the arm fastened to the side with a small pad in the axilla; but unless there is great comminution or bruising, in a few days it is sufficient to have the thorax bandaged and to carry the hand or forearm in a sling. Some deformity commonly persists, but there is rarely any permanent loss of power.

FIG. 124.—Fractures of the Anatomical and Surgical Necks of the Scapula.

*Fracture of the acromion* from direct violence is not uncommon, though many of the cases in which it has been found detached *post-mortem* are really examples of rheumatoid arthritis with separation at the epiphysial line, or of delayed union. It may give way at the tip or close to the spine. The signs are quite definite: the arm hangs helpless by the side, the shoulder is flattened, the line of the acromion interrupted, the outer fragment depressed and freely movable, and the patient is either unable to abduct the arm, or can only do so to a slight extent and with great pain. Crepitus can be obtained by direct manipulation, either on pushing the elbow upward or abducting and rotating the arm. If only the tip is broken all that is necessary is a triangular bandage to raise the elbow; but for the first few days it is advisable to strap the scapula closely to the thorax and to bandage the arm lightly to the side, so as to prevent accidental movement. Union, if the fracture is near the spine, may take place by bone; in front of this it is nearly always fibrous, but this does not interfere with the strength or the range of movement of the joint.

*The coracoid process* may be broken off by direct violence or by muscular action, but it is very rare. In the former case the injury, which may be caused either by a blow or by crushing, as when a cart-wheel passes over the axilla, is generally very extensive; in the latter there is scarcely any displacement, owing to the strength of the ligaments connecting the process to the clavicle.

*Fracture of the neck of the scapula* is almost equally rare. It can only occur by direct violence. The symptoms at first sight resemble those of dislocation of the arm, but the intense pain, undue mobility, and crepitus render the presence of a fracture certain. Moreover, the displacement returns as soon as reduction has been accomplished, unless means are taken to prevent it. Fracture of the surgical neck of the humerus can be excluded at once by the fact that the head of the bone in the axilla rotates with the shaft; but unless the coracoid process is movable it is almost impossible to make certain of the exact line of fracture in the scapula, especially as the amount of swelling is, generally speaking, very great, and dislocations are sometimes accompanied by injury to the glenoid fossa. The treatment is almost the same as in the other fractures of the scapula; the body of the bone must be fixed as well as possible, the elbow raised to take the weight of the limb off, a small pad placed in the axilla to act as a splint, and the arm bandaged to the side. Passive motion should be commenced early, not later than the third week. Even then it is probable that there will be a considerable degree of stiffness about the shoulder.

## FRACTURES OF THE HUMERUS.

### The Upper Extremity.

**Varieties.**—These may involve the surgical or the anatomical neck; or the epiphysis may be detached from the shaft; or the intracapsular portion may be split longitudinally and the head dragged forward so as to give the appearance of a dislocation.

Of these, fracture of the surgical neck is by far the most common, especially in the aged, when the medullary canal of the shaft is beginning to enlarge. Separation of the epiphysis can only take place under twenty; longitudinal fractures detaching the great tuberosity are not often met with unless there is dislocation at the same time, while fractures of the anatomical neck are among the rarest known.

#### (1) *The Surgical Neck.*

**Causes.**—Fractures of the surgical neck of the humerus may be the result either of direct or of indirect violence, of blows upon the shoulder, or of falls upon the outstretched arm; muscular action by itself is very rarely sufficient. The line of separation lies between the base of the tuberosities and the upper margin of the insertion of the teres major. In general the fracture is transverse, but it may be oblique to a greater or less extent, and impaction may take place, the upper end of the lower fragment being wedged into the cancellous tissue of the tuberosities (Fig. 125).

**Displacement.**—The displacement affects both fragments, but in very different degrees. In many cases there is scarcely any, the fracture is transverse, and the broken ends are kept in the same straight line by the biceps tendon. In others, especially if the direction is at all oblique, it is very considerable, and it may be a matter of great difficulty to retain the fragments in position. The upper of the two is abducted by the supra-spinatus and rotated outward by the infra-spinatus and the teres minor. The lower is drawn upward chiefly by the deltoid, and inward by the muscles passing from the thorax to the upper part of the arm, so that it may completely overlap the other and form a projection that stands out under the skin in the front wall of the axilla.

Fig. 125.—Fracture of Neck of Humerus.

**Symptoms.**—In some instances the amount of shortening is considerable, as much as three-quarters of an inch, though this is unusual. The rounded shape of the shoulder is not lost, but there is a depression some little distance below the acromion; the axis of the limb is altered; the elbow points backward and outward, though it may be brought into the side with very little pressure; and there is a certain amount of fullness about the front fold of the axilla. Undue mobility and crepitus are easily made out if the fragments are not impacted; the glenoid fossa is still filled by the head of the bone, and the upper end of the lower fragment can be felt projecting in front. Loss of power is complete, and often the pain is very severe, running down the arm, owing to pressure upon the brachial plexus.

Many of these symptoms are wanting when the fracture is impacted, but there is great pain, especially at the seat of injury, complete loss of power over the limb, a slight amount of deformity and distinct shortening. Extravasation is extensive, as a rule, and the swelling very distinct, especially on the inner side of the arm. In some cases it may be due to rupture of the circumflex arteries; in others it is merely the result of bruising and laceration of the muscles.

**Treatment.**—No attempt should be made to reduce an impacted fracture

unless the axis of the limb is seriously distorted. It is often difficult to bring the fragments into good position, and always harder to keep them there. All that is needed for such injuries is a pad in the axilla to act as a support, and a bandage round the arm to confine it to the side. In all fractures of the humerus the hand should be carried in a sling, but this should never be allowed to extend under the elbow.

When there is no impaction the upper fragment is practically out of control. It is so short and so deeply covered that very often it is difficult to be certain how far it is displaced. More may be done with the lower, though sometimes it is impossible to bring this into position and adjust it properly. It may be necessary to place the patient under an anæsthetic and to abduct and raise the arm from the side before the ends can be disengaged. The displacement inward is most easily met by placing a firm pad in the axilla, or, as Erichsen suggests, a piece of leather bent into the shape of a U, one side applied to the thorax and the other to the arm. If this is placed well up in the axilla, and if, at the same time, the elbow is carried slightly forward and fastened to the side of the chest by means of a bandage, the upper end of the lower fragment is carried outward and backward and the broken surfaces can generally be brought into good apposition. Then the hand is arranged in a sling, as already mentioned in the case of impacted fractures, and a cap of gutta-percha, or, what is better, as it is not so hot, of poroplastic felt, adjusted over the shoulder and down the arm, taking care not to bring it so far on to the neck that it becomes displaced by the movements of the head, or so far on to the thorax that it loses its grasp on the arm. This is fastened by a bandage carried round the opposite side of the chest. It must be admitted, however, that even when every care is used, union in a faulty position cannot always be avoided. Bandaging the hand and forearm is quite unnecessary (Fig. 126).

FIG. 126.—Bandage with Shoulder-cap and Sling for Fracture of Surgical Neck of Humerus. Part of sling cut away.

Union is generally complete in from five to six weeks, but the arm remains stiff and powerless for some time after. Passive motion should be commenced at the third week at the latest; in many cases it answers well to begin even before this, very quietly and gently, with the object rather of preventing the formation of adhesions by straightening out the folds of the capsule than of breaking them down. If this is not done the joint is sure to become rigid, owing to the mobility of the scapula, and it may be necessary at a later period to place the patient under an anæsthetic and work the part thoroughly. Delayed union and even complete failure occasionally occur.

### (2) *Separation of the Upper Epiphysis.*

This is not an uncommon accident under twenty years of age, and presents practically the same features as fracture of the surgical neck. True crepitus, however, is wanting, even when the line of separation runs between the cartilage and the bone; only an indistinct soft rubbing can be felt, and the upper end of the lower fragment, when it is made to project beneath the coracoid, is smooth and rounded instead of being sharp and angular. In some instances there is

considerable difficulty in reduction; the under surface of the upper fragment cup-shaped and prolonged downward upon its inner and anterior aspect, and it said that the edge of the lower fragment may be caught by this. To release the arm must be forcibly abducted and extended. In other cases it arises fr the upper end of the lower fragment being driven through the capsule.

Union, especially about the time of puberty, is very likely to be osseo impairing the growth of the limb. This, however, is not invariable, probab because in many of these cases the injury is really a fracture, running through recently formed bone without involving the cartilage. Complete failure has be known, and even suppuration, although the skin was unbroken. In two instanc in which union had taken place in so distorted a position that the arm was almo useless, Bruns separated the fragments again, resected part of the diaphysis, an wired them together with a good result. In one or two cases, in which the bone could not be brought into proper apposition, the joint has been laid open from the front, the interposing tissues divided, and the two fragments fixed together by means of a long drill driven through the skin. This was removed on the eighth day, as soon as sufficient lymph had been poured out to make the ends secure.

FIG. 127.—Vertical Section through Upper Epiphysis of Humerus, showing the Shape of the End of the Diaphysis.

It is possible for the joint to escape without being opened; the capsule is so firmly attached to the epiphysis that it may remain in connection with it, stripping off the periosteum from the shaft. More often it gives way upon the inner side.

### (3) *Fracture through the Tuberosities.*

Longitudinal fractures through the upper end of the humerus are not common. Sometimes, however, the great tuberosity is torn off by the contraction of the muscles when the head of the bone is dislocated; and occasionally the part is split by direct violence. When this occurs, the great tuberosity alone may be detached; or the line of separation may run through the head, or even along the bicipital groove, so that most of the articular surface is broken off, and the small tuberosity is left almost by itself on the end of the shaft.

**Symptoms.**—The character of the displacement is the same in all, though it varies in degree. If the tough tendinous periosteum at the insertion of the muscles is not torn, there is exceedingly little; in general it is very considerable. The breadth of the shoulder is the most prominent feature; this is immensely increased owing to the way in which one fragment is pulled forward and the other backward; and the axis of the limb is altered so that the elbow points backward and outward. Very little pressure, however, is required to bring it again into its normal position. As a rule there is no shortening, but there may be a great amount of bruising and extravasation, especially in cases in which the injury is caused by direct violence. Loss of power is complete. Crepitus is sometimes difficult to obtain on account of separation of the fragments; but the most characteristic sign is the presence of a bony projection under the coracoid in front resting on the anterior surface of the glenoid fossa, and under the acromion behind, with a deep furrow in between. The anterior follows the movements of the shaft, and corresponds more or less to the head of the bone; the posterior is the greater tuberosity drawn upward and backward by the muscles attached to it. The diagnosis of this peculiar accident requires especial care, as subcoracoid dislocation of the head of the humerus may be associated with it, and if it is not made out, serious deformity is certain to result.

**Treatment.**—If the displacement is only slight, all that is necessary is

[illegible]ce a pad in the axilla as a splint, and to support the elbow, either by means of a triangular sling or a four-tailed bandage; but this is quite exceptional. In general it is very considerable, and bony union may fail, as it is not at all easy either to bring the fragments together or to maintain them in that position. The simplest plan is to place a pad in the axilla, and try, with the aid of a bandage round the upper part of the humerus, to bring the upper end of the lower fragment backward and outward, while an attempt is made to press the other forward by strapping a pad firmly on it. If this fails the only alternative is to place the patient in bed, with a small pillow under the head, and to keep the arm extended and rotated out so that the hand lies on its dorsum. Even if union is bony it is a long time before full use of the joint is regained; the fracture often involves part of the articular surface, and lips of callus are thrown out around it; or the capsule becomes thickened and rigid, so that the range of movement is limited; or rheumatoid arthritis sets in afterward and leaves the joint permanently crippled.

### (4) *Fracture of the Anatomical Neck.*

Fracture of the anatomical neck is exceedingly rare and can only be produced by direct violence; most of the cases have occurred in old people, or at any rate after middle life, probably owing to the changes that take place in the substance of the bone. The line of separation is supposed to follow the anatomical neck of the humerus, but it nearly always lies partly inside, partly outside the capsule. It is very doubtful if such a thing as intracapsular fracture, in the strict sense of the term, has been proved. The head of the bone does not undergo necrosis, though union may be only fibrous or may fail completely; impaction is common, the upper fragment being driven into the substance of the tuberosities; where this does not take place an amount of nutrition sufficient to maintain life, though it is seldom enough to repair the injury, is kept up by the reflected portion of the capsule on the under surface of the neck.

**Displacement.**—In a few extraordinary instances the position of the upper fragment has been found completely reversed, the cartilaginous surface, that is to say, facing the tuberosities. It is very difficult to see how this is produced, but it is almost certain that it must be the result of forces acting subsequently to the fracture, perhaps long after. In other cases it is very slightly displaced, unless there is impaction, when it may be driven so far into the substance of the tuberosities as to split them in two. The lower fragment is held by the attachment of the capsule and the insertion of the muscles immediately below, so that it is only drawn upward and inward to a very slight extent.

**Symptoms.**—The most prominent symptoms are those due to the contusion. The loss of power is complete; the shoulder is swollen, tense, and painful; signs of bruising show themselves very soon, especially along the margins of the deltoid, and the whole of the upper and inner part of the arm may be blackened. If anything, there is a slight amount of shortening, and probably this is greater in impacted fracture; deformity is very little marked and is easily rectified; there is no undue mobility; but when the arm is raised from the side, and the head of the bone is felt in the axilla, a certain amount of irregularity can usually be detected. Crepitus is easily produced, unless there is impaction, by pressing the elbow upward so as to bring the broken surfaces in contact.

**Kind of Union.**—If the fragments are impacted, union, generally speaking, takes place by bone. In other cases it may fail completely, the two surfaces becoming hard and smooth from constant friction; or there may be a certain amount of fibrous tissue formed between them; or the head may be enclosed by a growth of bone, like a coronet, around it, so that it becomes quite fixed. In true intracapsular fractures union can hardly take place without impaction.

**Treatment.**—No attempt should be made to reduce impaction; it is true that the shortening and the deformity are, generally speaking, greater, but they are never serious, and impaction affords the surest promise of bony union. In

other cases all that can be done is to protect the shoulder, and carry the forea in a sling, with the elbow bandaged to the side, but no axillary pad. Care m be taken not to tear the capsule of the joint any further, as union depends m this to some extent. It is possible that the head of the bone may remain loos the cavity of the joint, and give rise to such an amount of inconvenience that removal may be required; but such an occurrence is very doubtful.

### *Fracture and Dislocation Combined.*

Fracture of the surgical neck of the humerus with subcoracoid dislocati occurring at the same time is not so rare an accident as might be imagine Nearly seventy cases of it have been recorded. In all probability the dislocati occurs first, and the neck of the bone gives way from a continuance of the sa force. The injury itself is not an easy one to make out, as all the ordinary sig of dislocation that depend upon the alteration in the axis of the limb are not o wanting, but point directly to fracture. The most characteristic feature is t absence of the head from the glenoid fossa.

The patient must be placed under an anæsthetic, and every effort made reduce the dislocation by squeezing the bone in the direction of the glenoid fo when all the muscles are relaxed. If this fails it is generally recommended to the fracture up, and when it is fairly well united to make another attempt; but any rate, in the case of a young and healthy patient, to whom it is of some con quence to retain full use of the limb, it is questionable whether it would not advisable to open up the joint and replace the head of the bone at once.

### *Compound Fractures.*

Compound fractures of the upper extremity of the humerus are not comm except as a result of gunshot injuries or of machinery accidents. The latter g erally require amputation as soon as the shock has passed off, but the questi must be decided in each case by the condition of the soft parts. Where they not seriously hurt every attempt must be made to save the limb, even if the bo is extensively splintered. The ends may be removed, the head of the bone excis or resection of a more or less formal character be performed with excellent resu Six inches of the bone have before now been removed.

Where, on the other hand, the soft parts are extensively injured, the sk stripped up, and the muscles badly torn, it is very doubtful, even if there is comminution, whether any attempt of the kind would succeed in leaving a servi able arm. The artery may be divided and tied at both ends; and the same m be done with the vein, without amputation being necessary, if the collateral cir lation has not been injured—practically that is to say, where the fracture is n due to direct violence. The nerves rarely give way unless the arm is almost to off; if, however, one of them has been divided, the two ends should be carefu sutured together with catgut.

## Fracture of the Shaft of the Humerus.

These are generally due to direct violence; sometimes they are caused by fa upon the elbow, and in a few instances they have been known to occur from m cular contraction; but though this is more common here than in any other bo the total number is not large.

**Displacement.**—The seat of injury is more often below the insertion of deltoid than above, and the fracture is generally oblique from above downw and outward. In children, however, and in fractures from muscular action may be nearly transverse. The lateral displacement is almost entirely depend on the direction of the fracture, and the action of the muscles. In injuries ab the deltoid it is worse than in those below; in the former the muscles that p

from the thorax to the arm pull the upper fragment inward, while the deltoid carries the lower one outward, and raises it at the same time; in the latter, these muscles antagonize each other to a great extent, so that the parts may remain in apposition. Shortening is rarely considerable, and in transverse fractures, especially if the periosteum is not torn, is absent altogether.

**Symptoms.**—All ordinary symptoms are well marked. The deformity when the arm is hanging by the side may not be conspicuous, but crepitus, undue mobility, ecchymosis, intense pain, and utter helplessness are nearly always present. In general there is no difficulty in feeling the fragments through the skin. The artery rarely suffers, but the musculo-spiral nerve, as might be expected from its peculiar relation to the bone, is often hurt, and still more frequently is injured by being compressed in the callus that is thrown out.

**Treatment.**—Fractures of the upper part of the shaft are treated in the same way as those of the surgical neck; only a short inside splint, coming down to the internal condyle, is better than an axillary pad; and the shoulder cap should be continued down the limb to the elbow, and be made to fit accurately round at least two-thirds of the arm. When they occur lower down, various appliances may be used. Four short, well-padded, wooden splints may be adjusted round the limb, the inner one reaching from the axilla to the inner condyle, the outer from the acromion to the external, and the anterior resting on the bend of the elbow. When these are secured by webbing-straps and buckles, or even with sticking-plaster, movement is hardly possible. Instead of the three outer ones, Gooch's splint may be employed. This consists of narrow strips of wood fastened parallel to each other, on one surface of a piece of wash-leather or moleskin, after the fashion of some kinds of dinner mats, so that it can easily be rolled round a limb. In several instances I have used the ornamental flower-pot holders that are made of diagonal interlacing bars, and can be opened or closed to any requisite width (Fig. 128). A layer of cotton-wool or of lint must be placed round the arm first, and care must be taken to cut away sufficient material to accommodate the elbow and the axilla; but when this is done they can be fixed with the greatest ease, and they are sufficiently elastic to fit without being unpleasantly rigid. Poroplastic felt may be used in the same way. Plaster-of-Paris is rather heavy. With all of these the hand must be carried in a sling, and the elbow allowed to drop, and of course the condition of the circulation in the hand and fingers must be carefully watched.

FIG. 128.—Splint and Sling for Fracture of the Shaft of the Humerus. Part of sling cut away.

Sometimes there is a considerable amount of shortening in oblique fractures. This can only be prevented by confining the patient to bed; hanging weights upon the elbow is useless so long as he is allowed to move about. The arm must be laid upon an inside splint, a stirrup fixed above the elbow, and a weight carried from it by means of a cord running over a pulley placed at a convenient angle by the side of the bed.

Where the upper fragment is much displaced or where, from the age of the patient or other causes, it is not considered advisable to carry a bandage round the thorax, Middledorpf's triangle is the best contrivance. This consists of a light, well-padded triangular framework; one side runs down from the axilla to the hip, a second from the axilla to the elbow, and a third joins the lower ends of the other two. The object is to secure the elbow and shoulder, and at the same time keep the arm fixed in abduction.

Union generally takes place in five or six weeks, but total failure and f joint are more common in the shaft of this bone than in any other. It has noth to do with the position or direction of the nutrient artery, nor is it in any way result of separation of the fragments for want of support at the elbow joint. has been assigned, with more probability, to the fact that neither the shoulder the elbow joint is properly fixed, so that more movement takes place at the seat injury than is advisable; but it is very doubtful whether the means adopted obviate this do not do more harm than good. Angular splints, for example, Hamilton pointed out, soon make the elbow stiff, so that if the forearm drops all, or if any attempt at movement is made, the fracture yields, and not the joint Certainly, in many instances of ununited fracture, the elbow joint is stiff. Further, if an inside angular splint is applied to the arm, and then the hand placed in a sling, the elbow becomes abducted at once, and this movement takes place more easily at the seat of fracture than it does at the shoulder. Probably the real cause, in the majority of instances, is the interposition of some foreign substance—generally speaking, muscle; and its frequency may be explained by the very extensive surface of the shaft that affords attachment to the brachialis anticus and triceps. If the direction of the fracture is in the least oblique, either fragment may be easily driven so far into the soft parts that it is almost impossible to disengage it. In one or two instances the musculo-spiral nerve has been found between the fragments.

The treatment depends upon what can be made out with regard to the position of the fragments; if they are in apposition with each other, any of the methods already mentioned, in speaking of delayed union, may be adopted; but if it is practically certain that there is some intervening substance, union is impossible until this is removed. It is essential, before attempting any operation of this kind, to encourage the circulation through the limb by galvanism, friction, and whatever kind of movement is possible. When an arm has been confined in splints, or carried in a sling for many months together, the nutrition becomes so much impaired that, not unfrequently, even such a proceeding as wiring the fragments is entirely unattended by the formation of callus.

### Fracture of the Lower End of the Humerus.

A certain amount of confusion has arisen with regard to these from the variety of names employed. This may be avoided by making use of the term epicondyle for that part of the bone, internal or external, which lies outside the capsule and gives attachment to the muscles, reserving the word condyle to include part of the joint.

The line of fracture may either be wholly outside the capsule of the joint or may involve [illegible]

[illegible] transverse fracture above the olecranon [illegible] of the internal epicondyle, and separation of [illegible] The external epicondyle does not project [illegible]

[illegible] separation of either condyle, the line [illegible] the centre of the [illegible] and separation of the [illegible] the firmness with which the capsule [illegible] the [illegible] without opening the [illegible] fingers in cases of fracture [illegible] may take place by rise [illegible] as if the three ossi [illegible] some rent in the synovi [illegible]

[illegible] muscle surrounds the coronoid depr

on the front of the bone, and on either side encloses the trochlear and itellar surfaces, skirting the cartilage of the latter very closely. Behind it cludes the whole of the olecranon fossa, but not that part of the bone that lies ove and behind the radial surface; this is altogether uncovered. The line of ction between the epiphysis and the shaft separates off both epicondyles and e whole of the cartilaginous surface, running transversely across the centre of e bone and turning upward at either end, so that, as the external epicondyle is ever detached by itself, separation of the internal is the only form of injury that an take place without throwing an immense strain upon the capsule, a strain so great that practically it always gives way.

The relative situation of the olecranon and the two epicondyles, as compared with those on the opposite arm, is of the highest importance in the diagnosis of injuries in the neighborhood of the elbow joint. Measurements should be taken in all positions of the limb, and the transverse diameter, from the tip of one epicondyle to the tip of the other, should not be neglected.

Fractures of the lower end of the humerus are more common in children than in adults; they are often complicated with dislocations; and if the diagnosis is not made at once they are always attended with such a degree of swelling that it can hardly be made at all. Impairment of mobility is a very common result, especially when the joint is involved; the fragments are exceedingly difficult to retain in position; a large amount of callus is often thrown out by the extra-articular part, so that the fossæ are filled up and the bones lock too soon, and the capsule is very likely to become thickened and rigid from the development of extra-articular adhesions. In children an accident to the elbow is not an uncommon precursor of tubercular mischief.

### 1. *Fractures External to the Joint.*

Transverse fracture above the condyles: supra-condyloid. In some cases this involves the reflection of the synovial membrane in the olecranon fossa; usually it is situated a little above.

It is generally produced by falls upon the elbow, the tip of the olecranon, perhaps, acting like the apex of a wedge, splitting the bone across; but it may be caused by direct violence, or by the cross-breaking strain in over-extension of the elbow joint in place of dislocation. The line of separation is fairly transverse from side to side, but very often is oblique from above downward and forward, and this determines the displacement.

FIG. 129.—Fracture of the Lower End of the Humerus.

The deformity is almost the same as that of dislocation of both bones of the forearm backward, but it is not at the same spot. The elbow joint is flexed and the hand generally pronated; the olecranon projects behind with a great depression above, in which the tendon of the triceps stands out distinctly; in front there is a prominence due to the lower end of the upper fragment; but as soon as the injury is examined with the hand it is found that the relation of the olecranon to the two condyles is unaltered, and that the projection in front is not the articular surface of the humerus, but is on a distinctly higher level. In addition to this the length of the humerus is altered; crepitus is present; there is undue mobility, instead of the joint being fixed; and, what is most important of all, if the deformity is rectified, it returns as soon as the arm is released. In cases in which the amount

of swelling is so great as to obscure all the bony prominences, this test may be relied on absolutely; the only other injury in which it is present is dislocation backward combined with fracture of the coronoid process, and this is distinguished by the fact that the condyles of the humerus still retain their relation to the shaft.

FIG 130.—Common Form of Malposition after Fracture of Lower End of Humerus.

When the line of fracture runs in the opposite direction across the bone, the symptoms are not so characteristic, as there is no projection of the olecranon; but all the ordinary signs of fracture—shortening, crepitus, undue mobility, and pain—are well marked.

**Treatment.**—Reduction is easily effected, but when the fracture is oblique there is some difficulty in maintaining the length of the limb, owing to the strength of the muscles. Swelling is often very considerable if the fracture is not put up at once. It may not be so bad as when the injury traverses at the joint, but, if it is at all serious, the patient should be confined to bed, and the limb fastened lightly to an inside angular splint. Cold applications are generally recommended, and they are of great use at first; the vessels become constricted under their influence, the extravasation ceases, the exudation of lymph is limited, and the swelling of the joint is checked; but, after the first few hours, gentle compression, if it can be managed with safety, is much more effectual. It requires, it must be confessed, the utmost care; a thick layer of cotton-wool must be used, the fingers must be constantly watched to see that the circulation is being carried on properly; the pulse at the radial must be felt from time to time, and the bandages must be put on after the limb is in position (most of the disastrous cases of gangrene have been caused by the dressing being applied to the limb when it was extended, so that as soon as it was flexed the bandage cut deeply into the fold of the joint); but if it is properly carried out there is nothing that succeeds so rapidly or so surely in removing the swelling and preparing the limb for a more permanent apparatus. It is of great importance to limit the amount of exudation poured out around the end of the bone; sometimes, especially when the fracture involves the joint, it is so excessive that the lower part of the humerus appears to be converted into an almost shapeless block, and movement is checked in all directions.

The most convenient form of splint is rectangular, made of some plastic material, arranged along the posterior aspect of the arm and the under surface of the forearm from the axilla to the wrist. With this there should be a short anterior one down the arm, thickly padded opposite the bend of the elbow, so as to correct as far as possible the tendency to forward displacement of the upper fragment. The hand must be carried in a sling. In some few cases an anterior angular one appears to answer better, but the ordinary metal or wooden inside splint, with joint at the bend, is of little use unless the patient is confined to bed.

Passive motion should be commenced not later than the end of the second week, but extraordinary precautions must be taken. There is danger on both sides if the elbow is allowed to become stiff, non-union may occur, though it is not as frequent as higher up in the shaft; if, on the other hand, the seat of injury is not securely held, the soft callus yields, and is liable to become broken up and absorbed. If the fracture is low down, extension is often limited, owing to the way in which the olecranon fossa becomes filled up, but this is not nearly so bad as in T-shaped fractures; and even in the worst cases great improvement takes

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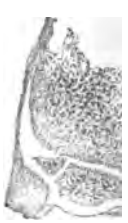

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[illegible], as in the case of compound fractures into other joints, must be guided by [illegible] age and constitution of the patient, and by the extent of injury to the soft parts [illegible] the bones respectively; but this is modified to a certain extent as regards the [illegible]ow by the excellent results that are obtained by excision. If there is but little [illegible]minution, and the wound is small and clean cut, the part should be thoroughly [illegible]nsed with corrosive sublimate, the wound sealed with a dressing of wood-wool [illegible] some similar absorbent material, and the limb arranged upon an angular splint, [illegible]d slung with a counterpoise from a pole over the bed, as in an excision. But if [illegible]e bone is extensively injured or the skin much bruised, so that the amount of [illegible]vement in the joint afterward is a matter of some doubt, it is better to excise [illegible]e part at once. Amputation is only required when the soft tissues are destroyed [illegible] such an extent that there is no prospect of the limb recovering.

## FRACTURE OF THE RADIUS.

This may involve the head, the neck, the shaft above the insertion of the pronator radii teres, or the lower extremity. When the shaft is broken the ulna, generally speaking, gives way, too.

*Fractures of the head* are very rare, but occasionally they are produced either by direct violence crushing the external condyle or by falls upon the hand. They have been found in several of the instances in which the coronoid process was broken. The line of fracture is usually longitudinal, splitting off more or less of the circumference of the bone.

*Fracture of the neck* of the bone is still more uncommon, though it is an injury that is often suspected during life. It may occur in children or in adults, probably from direct violence, though one or two instances are recorded in which it has been due to falls upon the hand. The head of the bone is unduly movable and does not rotate with the shaft; pronation and supination are impossible, and when the hand is moved in either direction there is intense pain at the seat of injury; a slight amount of crepitus is usually present. I have met with one instance in which the upper epiphysis was separated, the external condyle of the humerus being considerably crushed at the same time. The only treatment that can be adopted is to retain the elbow joint in a light form of rectangular splint with a firm pad over the front of the forearm, and to commence passive motion as in fractures of the lower extremity of the humerus. If, owing to the contraction of the biceps, the displacement cannot be rectified in any other way, the arm must be put up fully flexed; but it must be recollected, when passive motion is begun, that the muscle is very likely to have become rigidly contracted from prolonged rest. The position of the posterior interosseous nerve in relation to the bone must not be forgotten in connection with this fracture.

FIG. 133.—Separation of Upper Epiphysis of Radius with Crushing of Capitellar Surface and External Epicondyle.

*Fractures of the shaft* of the radius alone are due either to falls upon the hand or blows upon the arm, and may take place either above or below the insertion

of the pronator radii teres. In the former case the upper fragment is acted by the supinator brevis and the biceps, the lower by the pronators, so that relative position of the radius and ulna is not the same above and below seat of injury. In the latter the upper fragment, owing to the attachment of pronator teres, is not much displaced; but the lower is tilted inward tow the ulna, partly by the supinator longus, partly by the pronator quadratus.

So long as the ulna is intact the amount of deformity is very slight. Th other signs are well marked: there is intense pain over the seat of injury; pa nation and supination are impossible; when the hand is grasped and made rotate, the upper end of the radius does not move with it, and crepitus can felt at once.

Fractures of the upper part of the bone should, if possible, be put up in a position of complete supination. The upper fragment is already in that position, and if the lower is partly pronated it is clear that a certain amount of supination must be lost, and though this can be supplemented to a great extent by rotation at the shoulder-joint, especially after long practice, the movement at the elbow

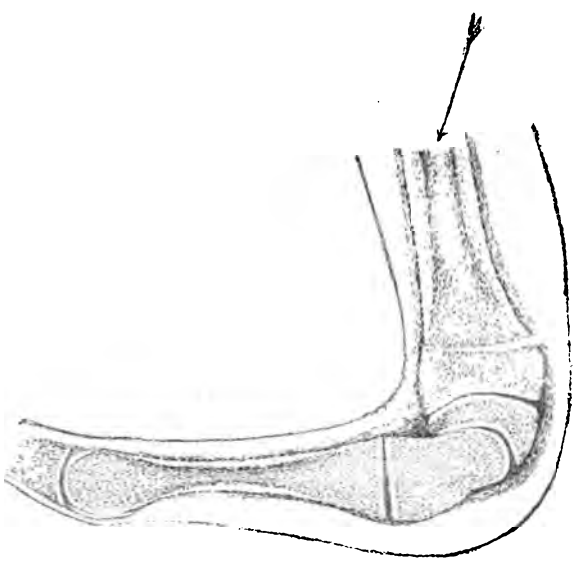


Fig 134.—Section through the Lower End of the Radius, the Carpus, and Metacarpus, to show the Position in a Fall upon the Hand and the Influence of the Inferior Radio-carpal Ligament. If the force were continued, the hard, compact anterior surface of the radius would be driven into the cancellous tissue of the lower fragment.

is exceedingly awkward. It seldom happens, however, that patients will endure it; if they are confined to bed the arm may be laid on its back and completely extended; if not, all that can be done is to fit a posterior rectangular splint down the arm and forearm and to arrange a sling so that the hand, resting on its dorsum, is as much in front of the median lateral line of the body as the elbow is behind.

When the seat of injury is below the insertion of the pronator teres, the danger is that the upper end of the lower fragment may be drawn inward and at length unite with the ulna, when, of course, both pronation and supination are lost. To prevent this, straight back and front splints must be used, wider than the limb, so as to take off all lateral pressure, and well padded, especially down the centre, so that the muscles may be squeezed as far as may be into the interosseous space; and the limb should be put up midway between pronation and supination, that is to say, with thumb uppermost and the dorsum of the hand looking forward. The sling should only take the forearm, so that the hand may hang down in a position of adduction.

*Fracture of the Lower End of the Radius.*—With the exception of the clavicle the bone is broken more frequently than any other. The fracture is usually transverse from side to side, though in the vertical direction it may incline from above downward and forward, and it nearly always lies within an inch of the carpal surface. The size of the lower fragment, however, varies considerably; it may be merely a plate of bone carrying the articular cartilage.

The cause is almost always indirect violence, a fall upon the hand. If the palm is toward the ground, the displacement is dorsal (Colles' fracture), and it may be impacted, or non-impacted, or comminuted; if, as occasionally happens, the hand is doubled underneath so that the back is downward, the lower fragment is forced in the opposite direction.

*Colles' Fracture.*—For many reasons this is of special interest; it is exceedingly common; it is much more often met with in women past middle life than in men; it is distinguished by displacement of a very striking character; and it often leaves behind it unsightly deformity and a very serious degree of stiffness.

The structure of the lower end of the radius favors its occurrence. The compact tissue of the shaft is firm and strong, but over the articular end it is scarcely thicker than paper, and one part passes very abruptly into the other. In men of good muscular development the bony ridges in the back and at the sides strengthen it sufficiently; but in women these are almost wanting and the whole bone is more smooth and rounded. As age advances the medullary canal enlarges and encroaches upon the centre of the articular end, the cancellous tissue grows more open, and the trabeculæ becomes thinner and fewer in number.

The immediate cause is a fall upon the hand, but not, as usually described, outstretched. This may dislocate the elbow or the shoulder, or it may break the surgical neck of the humerus, but it can hardly cause a transverse fracture through the radius. The hand is really almost under the body, the radius is much more vertical than horizontal, the wrist is violently over-extended, the lower fragment is fixed by the inferior radio-carpal ligament, and the cross-breaking strain snaps the bone in two. In men it occurs most frequently in falls from some considerable height, when they pitch upon their hands, or in accidents on the ice from the feet suddenly slipping up. (I have known, on a frosty morning when the roads were very slippery, seven patients, one after the other, come to the hospital with this form of fracture.) In women it comes from slighter falls, for not only is the bone relatively much weaker in proportion to their weight, but, partly from their mode of dress, partly from their inability to save themselves, they come down upon their hand with much greater force.

If the violence is only moderate in degree, the bone is merely broken across; if it is more severe there is impaction (in at least two-fifths of the cases and probably many more); the compact tissue of the dorsal surface of the upper fragment is driven into the cancellous tissue of the lower, without the periosteum on the back being torn; if the violence is greater still, there is comminution, the impaction being carried so far that the lower fragment is split into pieces.

FIG. 135.—Section through Forearm showing Displacement in Colles' Fracture.

*Displacement.*—The displacement is threefold; the upper fragment is held fixed by the pronators, the lower is carried bodily toward the dorsal surface, so that it no longer lies in the same plane; it is rotated round a transverse axis so that its articular surface, instead of looking almost directly forward, looks forward and upward, and the outer side is, as a rule, displaced much more than the inner, partly because the latter is held by the triangular fibro-cartilage,

partly because in falling upon the hand the radial side of the carpus rec the brunt of the shock. The original displacement is due, there can be doubt, to the crushing force; but Colles himself attached much import to the contraction of the extensor muscles of the thumb, which pass over posterior surface of the radius in sheaths firmly connected to the bone.

FIG. 136.—Outline of Hand in Colles' Fracture.

**Symptoms.**—If t bone is merely broken acr the deformity is not ve marked, but if there is paction or comminution, i most conspicuous. Look at from the radial side back of the hand appe strangely long, the natural de pression of the wrist seems have disappeared, and in place there is another an inch and a half or two inches higher up. Opposite this, on the flexor surface, the tendons are raised and thrust prominently toward the skin, while the wrist itself is unusually arched. Seen from above it is still more striking; the hand is displaced toward the radial side and abducted, the ulna stands out as if it were coming through, the fingers are flexed, pronation and supination are impossible, and the patient carefully supports the injured wrist in the palm of the other hand. Swelling sets in very soon. The flexor tendons are always hurt by being strained over the end of the bone, and their synovial sheath becomes filled with fluid at once; but this rather serves to exaggerate the deformity than to conceal it. The margin of the ulna can be traced down without any difficulty; and by firm pressure on the outer border of the radius it is nearly always possible to make out the line of separation; but crepitus and undue mobility are rarely very distinct unless there is comminution.

Sprains of the flexor tendons of the wrist are sometimes mistaken for Colles' fracture; they are caused in the same way, and it is difficult to prove that the bone has escaped unhurt and that the tendons by themselves have been sufficiently strong to stand the strain.

The reduction of the deformity is often a matter of the greatest difficulty. Colles states, it is true, that a moderate degree of extension is sufficient to restore the limb to its natural shape, and that it slips back again at once; but this only occurs when there is comminution. Gordon, who denies impaction, and who describes the broken surface of the upper fragment as convex from within outward, and also from before backward, believes that the difficulty is entirely due to the rotation of the lower fragment; if the upper one is fixed, the lower pressed forward, and the hand flexed to an angle of 45°, the concavity of the radius is restored at once. If there is no impaction, the obstacle must of course be due to locking of the fragments or muscular spasm; but there can be no question that it is present in a very large number of instances (probably the majority); and that the difficulty arises partly from this, partly from the small size of the lower fragment, which makes direct extension almost impossible.

Direct manipulation of the fragments while extension is being made from the hand is very often successful. If this fails, adduction may be tried at the same time, the lower end of the ulna being used as the fixed point, and the forearm being held in a position of supination with the elbow flexed; but care must be taken not to put too much strain upon the ligaments. If this does not succeed another trial may be made at the end of a week, when the fragments have become softened to a certain extent; but it is not likely to be successful, and it is advisable to caution the patient from the first that there will probably be a certain amount of permanent deformity.

**Treatment.**—This depends upon the success with which reduction is accomplished. If the fragments cannot be separated, all that is required (so far as

cture is concerned) is a simple wristlet, made of some light material, to protect part from further injury. Union in these cases is very rapid, but it must not forgotten that the flexor tendons are generally hurt at the same time, and that, less steps are taken to prevent it, stiffness of the wrist and rigidity of the fingers almost certain to follow.

If, on the other hand, the fracture is transverse without impaction, or if it is mminuted, and the deformity has really been reduced, the broken surfaces can kept in contact with the simplest of contrivances. Either Carr's or Gordon's lint answers perfectly; but equally good results may be obtained by fixing the rearm midway between pronation and supination, in two straight wooden es, reaching from the elbow to the bases of the metacarpal bones. After a week ten days they may be replaced by a well-devised poroplastic gauntlet, including the thumb and the flexor surface of the forearm.

Adduction is of no use unless there is comminution; but then, in some instances it is of great service. It is managed most easily by means of a pistol-haped splint, arranged either on the dorsal or the palmar surface, with a short one on the opposite side for counter-pressure. The pads should be arranged as they are in Gordon's.

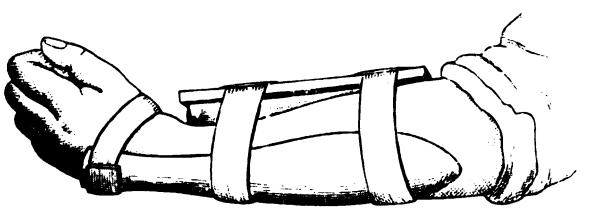


FIG. 137.—Gordon's Splint Applied.

Gordon's splint consists of a dorsal and a palmar portion; the former is much the longer and is bent down at its lower extremity so as to maintain the wrist-joint in a position of semiflexion; the latter is very short, and is either carved or padded so as to fit into the concavity of the radius. If it is padded the edge of the splint projects like a flange so as to avoid lateral pressure. It should be kept well up on the forearm, not allowed to encroach upon the wrist.

Carr's is simpler. The flexor splint is made of wood and is about eleven inches long and two wide; across the end of this is a round bar placed obliquely, so that when the fingers are flexed over it the hand is slightly adducted. It should be stoutly padded opposite the upper fragment on the radial side. A dorsal splint may be used with it, but in many cases it is not necessary.

*Stiffness.*—It is always necessary to warn patients that Colles' fracture is liable to be followed by stiffness, affecting both the fingers and the wrist, especially if there is any tendency to gout or rheumatism. It is due, in many cases, to strain of the flexor tendons; but it is made tenfold worse by rigid confinement, and it is by no means unlikely that, in certain circumstances, this is sufficient of itself. So far as the fingers are concerned, it can generally be avoided; they should never be bandaged; one great merit of Carr's splint is the freedom of movement it gives them; and passive motion must be commenced and thoroughly carried out from the first day. With the wrist it is more difficult, but on several occasions I have begun gentle manipulation on the fourth or fifth day with an excellent result. Pressure should be carefully applied along the forearm

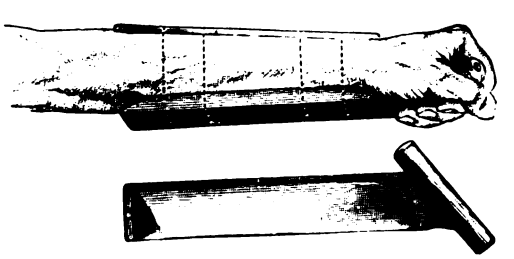


FIG. 138.—Carr's Splint.

if there is much effusion into the sheath of the tendons; and as soon as fracture is fairly firm, massage, counter-irritants, and steaming must be commenced; but not uncommonly it is necessary to place the patient under anæsthetic, and work every joint thoroughly, before there is much improvement. If there is comminution of the lower fragment, or if the impaction is not reduced and the plane of the articular surface restored, some limitation of movement usually persists.

Fracture of the lower end of the radius with palmar displacement is very rare and does not present any special features. Separation of the lower epiphysis may occur; and, if union takes place by bone, the growth of the ulna may lead to serious distortion of the hand.

Compound and even comminuted fractures of the lower end of the radius may be produced by direct violence, without of necessity the joint being involved. In one case under my care, in which a man's wrist was pinned against the ground by the sharp edge of a beer-cask, though the bone was broken to pieces, the joint and both the arteries escaped unhurt.

## FRACTURES OF THE ULNA.

These may involve the olecranon, the coronoid process, or the shaft.

*Fractures of the Olecranon.*—This process is frequently broken, especially in adults, in falls upon the point of the elbow; and it has been separated by muscular action. As a rule it gives way at its narrowest part, laying open the joint, but occasionally the tip only is detached, and then it is possible for the synovial membrane to escape. Stellate fractures are sometimes met with.

The amount of separation depends upon the extent to which the aponeurosis of the triceps and the fibres of the capsule at the side give way. If they are torn the upper fragment is raised by muscular contraction and the distention of the joint cavity until there is a wide gap between them. More rarely the broken surfaces remain in contact, and crepitus can be obtained. Loss of extension is complete, manipulation and pressure are exceedingly painful, and the amount of swelling is generally very great.

**Treatment.**—If the bruising is severe, the arm should be laid upon a pillow for the first few days, in a position of easy extension, and cold and pressure applied until the swelling is in some measure reduced. In most instances all that is necessary is a light wooden splint running down the front of the limb, sufficiently long to hold both arm and forearm firmly. It should be thickly padded opposite the joint, as absolute extension is uncomfortable, and has a tendency to tilt the surfaces. Sometimes the fragments can be brought closer together by a figure-of-eight bandage, or by loops of strapping, so arranged as to pull the upper one downward; but in many instances this seriously increases the swelling of the limb. It is more satisfactory to bandage the part carefully and evenly with abundance of wool around the joint, so as to insure early absorption of the fluid and thorough relaxation of the muscles. This position should be maintained for three weeks, and then the arm may be gradually bent, until in about ten days the forearm rests easily in a sling. If there is much separation, union is nearly sure to be fibrous; but so long as it is fairly close and strong it does not interfere with the use of the limb. Stellate fractures unite by bone. Flexion from the first has been recommended by some, on the ground that if ankylosis were to occur the arm would be in a more convenient position; but there is seldom any reason to fear this. Fig. 131

If union takes place while there is no power of extension, the fragments may be drawn apart and united together. I have seen one instance in which the [illegible] was lost, owing to the upper portion becoming united to the humerus.

[illegible] is not uncommon. If it is merely transverse, the fragments should be kept in apposition; if there is comminution, every effort

must be made to save the part; but if there is any fear of suppuration, it is better to perform excision.

*Fracture of the coronoid process* is a very rare form of accident, and is nearly always associated with backward dislocation of the bones of the forearm. It may be produced by direct violence crushing the bone, or by falls upon the hand when the elbow is extended; the shock must be transmitted from the radius to the ulna, and from this to the trochlear surface of the humerus. The tip also may be detached by violent abduction, or adduction, of the forearm. The brachialis anticus is attached to its anterior surface, near the base, so that fracture from muscular action alone can hardly take place, and separation of the tip from this cause is impossible. The most important symptom is the displacement backward of the bones of the forearm, when the elbow joint is extended, returning as soon as the reducing force is relaxed. In addition there is intense pain on pressure, increased by attempts at flexion, and, unless it is merely the tip, there is a considerable amount of swelling. It is recommended to keep the elbow joint flexed at a little less than a right angle, secured by plaster or a fixed bandage, and commence passive motion at the end of a week. If the fragments are at all separated, union is sure to be ligamentous.

FIG. 139.—Fracture of Olecranon, with Fibrous Union.

*Fracture of the shaft of the ulna* by itself is usually the result of direct violence, and, because of the exposed situation of the bone, is often compound. It may give way at any part, but owing to its comparative weakness it is more common below the middle. The line of separation is usually distinct, unless the amount of bruising is too great, and the movements of the arm are restricted and very painful. The displacement is not conspicuous, unless the radius is broken or dislocated at the same time.

If there is any tendency for the ends to be displaced outward toward the radius, the fracture should be put up as if both bones were broken. In other cases a shield of gutta-percha, long enough to grasp the whole of the forearm and the ulnar side of the hand, is quite sufficient. As the hand, when placed in a sling, rests upon the ulnar border, care must be taken that the fragments are not displaced by direct pressure.

Fracture of the styloid process of the ulna is not uncommon when the lower end of the radius is broken and the hand much abducted. Union is usually fibrous.

*Fracture of the radius and ulna together*, in the middle of the forearm, may occur from direct violence, or from a fall upon the hand. In children the fracture is often partial or greenstick; and the only prominent sign is an angular deformity, generally an exaggeration of the normal curve. When the separation is complete, crepitus and undue mobility are present. Pain, swelling, and loss of power occur in all alike.

Greenstick fractures must be straightened as far as possible; sometimes this cannot be done without making them complete; but if there is only a small angle, not sufficient to interfere with pronation and supination, it disappears to a great extent as the child grows older. When the injury is above the level of the pronator radii teres, the forearm should be put up in the position of complete supination, as already described in speaking of fracture of the shaft of the radius alone. When it is lower down, two straight splints should be used, wider than the limb and thoroughly well padded, especially down the centre, so as to avoid as far as possible any risk of cross union; and the fracture should be set with the limb midway between pronation and supination, that is, with the thumb upward and the dorsum of the hand forward. Passive motion should be commenced in about three weeks, as there is some risk of the interosseous membrane becoming thickened in the region of the fracture and losing its flexibility. No bandage should

ever be applied under the splints, and care must be taken to examine the fract every day for at least the first week. It is in this form of injury that gangren especially common, to some extent, as already mentioned, from flexion of t elbow, but also because both radial and ulnar arteries are easily compressed agai the bones for a considerable portion of their course.

### Fractures of the Carpus and Metacarpus.

*Fracture of the carpus* is not common, owing to the mobility and protecte position of the bones, and to the way in which the pressure is distributed amon them. They may give way, however, from direct violence. Exact diagnosis, unles the injury is compound, can rarely be obtained, especially as the amount of bruising is always extensive. As a rule it is sufficient to carry the hand in a sling, and for the first few days to protect the part from careless movements by means of a light palmar splint of gutta-percha, recollecting that the natural position for the joint is one of slight extension. Unless there is comminution or fear of suppuration, passive motion should be commenced as early as possible, so as to avoid permanent rigidity.

*The metacarpal* bones are often broken from direct blows, as in fighting, the first, from its exposed situation, giving way the most frequently, the third the least. The displacement is nearly always toward the dorsum of the hand, an exaggeration of the natural curve, so that the head is turned to the palm. If seen at once, it can easily be rectified by direct manipulation; but often the patient does not apply for some days, considering it a mere bruise. The plan recommended by Astley Cooper, of placing a ball in the palm of the hand, and extending the finger over it, answers very well, and maintains thoroughly the natural curve; but, as a rule, a simple gutta-percha splint, well moulded, is quite sufficient and is much less cumbersome. The metacarpal bone of the thumb is liable to a peculiar form of fracture which can easily be mistaken for dislocation, as it does not involve the dorsal surface of the bone. The palmar half of the base is broken off; the length of the bone is unaltered, but the security of the articulation with the trapezium is lost, and the bone keeps constantly slipping back. Crepitus can be felt by pressing the detached fragment from the palm outward toward the rest of the bone. Union is generally attended with some impairment of movement.

Simple fracture of the phalanges is very common, and may be treated either with a light pasteboard splint or a gutta-percha trough, keeping the finger nearly extended.

Compound fractures extending into the wrist joint are very serious; the bones are generally crushed, the joints torn open, and often the soft parts extensively injured as well. The question of amputation must be decided by the last-mentioned consideration; I have on several occasions treated fractures of this description, it which it was necessary to remove fragments of bone from both rows of the carpus, with corrosive sublimate baths for an hour each day, not only without suppuration, but with an excellent result so far as movement was concerned. If inflammation and suppuration once set in, the whole carpus is almost sure to become involved, the bones undergo necrosis, and the pus is very likely to spread from the articulations, either into the synovial sheaths of the tendons, or into the deeper planes of cellular tissue, until the whole limb is implicated. If this subsides, the hand and wrist are almost useless; more often than not amputation is required to prevent more serious consequences.

Compound fractures of the hand, if they are at all extensive, if for example the palm or several fingers are badly crushed, should be treated in the same way. It is often impossible to tell at the first how much of the bruised and damaged tissue will live, and every fragment is of importance. The sloughs, it is true, are somewhat slow in separating, but, owing to the amount of the antiseptic dead

[illegible]es absorb, putrefaction does not take place; there is no fear of cellulitis or [illegible]er inflammatory complications; granulations gradually spring up, and the [illegible]ole of the tissue that is not too much damaged by the accident is preserved.

## FRACTURE OF THE PELVIS.

The innominate bone may be broken by direct violence or by muscular action; or the pelvic girdle may be squeezed until it gives way under the pressure. In this case the position and direction of the fracture are often definite; under other circumstances they are very variable.

### Fractures of the False Pelvis.

Portions of the crest of the ilium are occasionally broken off by direct blows; in a few rare instances the anterior superior spine has been detached by muscular action; and the same thing has been known to occur in the case of the epiphysis that forms the crest; but unless there is great comminution, injuries of the false pelvis are rarely attended by serious consequences; the shock may be severe; the ordinary signs of fracture are well marked; but the viscera very seldom suffer; and repair takes place readily, though there is often a certain amount of difficulty about retaining the fragments in proper position.

### Fracture of the Acetabulum.

This may be produced in two ways: in the first, and the most serious, the head of the femur is driven inward with such violence that it splits the cavity into pieces; in the second a portion of the lip only is detached. The former of these never occurs except as the result of extreme violence applied to the great trochanter; the bone is very much comminuted (the three portions that form the acetabulum being driven asunder), the shock extreme, and the danger of injury to the viscera very great.

The position the limb assumes closely resembles that of fracture of the neck of the femur, but the trochanter is more sunken. The amount of mobility varies a good deal; in many instances it is unusually free, probably owing to the small relative size of the neck compared with the head; crepitus is generally distinct, and manipulation exceedingly painful. If there is any doubt, an attempt may be made to feel the head of the bone through the rectum or vagina. The accident frequently proves fatal from shock or from injury to the viscera; if the patient rallies sufficiently, an attempt must be made to extract the bone, but it is not very likely to succeed; if it does, the limb must be put up as in fracture through the base of the neck. Movement is sure to be much impaired.

Fracture of the lip of the acetabulum is more common. It is caused by the sudden impact of the head of the femur against the upper and back part of the cup, and may be produced by falls upon the feet. In one instance, however, under my own observation, it was clearly shown that the upper part of the body struck the ground first, so that in all probability it was produced in the same way as the fracture that is met with at the base of the skull from the sudden shock of the atlas coming upon the occipital condyles with the weight of the body behind it. The position the limb assumes is almost identical with that of dislocation backward; reduction is easy, but as soon as the hand is removed the head of the bone slips back. Crepitus can generally be felt if deep-seated pressure is applied above and behind the great trochanter while extension is being made. This injury must be treated in the same way as fracture through the base of the neck of the femur. The patient is to be kept in bed with a long splint and weight-extension, pre-

portionate to the strength of the muscles, for at least three weeks. After th permanent appliance is to be worn for six weeks, or two months more; the must be slung, and no weight allowed to rest upon the limb until at least length of time has elapsed, though passive motion may be commenced earlier. In most cases there is a certain amount of shortening afterward, but use of the limb is not impaired.

## Fracture of the Sacrum and Coccyx.

*The sacrum* is occasionally, but very rarely, broken by direct violence. lower portion suffers more frequently than the rest, owing partly to its we construction. If the fracture is compound, as it often is, it must not be forgot that the spinal canal runs down the middle of the bone, and that meningitis occur. When there is great comminution, the structures on the anterior surfa in particular the nerves as they issue from the foramina, may be involv as well.

*The coccyx*, on the other hand, is frequently injured by falls in a sitt position upon something hard, or by kicks. Sometimes it is broken right acr and displaced, so that crepitus can be distinctly felt when it is grasped between t fingers, one in the rectum, the other on the skin, and moved backward and f ward; more often it is only bent or partially broken. Perhaps, sometimes, t injury is really a dislocation. The most prominent symptom is the pain caus when any of the muscles attached to the bone are called upon to act; sittin stooping, walking, coughing, and especially defecation are attended with muc suffering. The displacement is easily reduced, but is very liable to return. Th only treatment is to keep the patient in the recumbent position for a few days unt the pain has to a certain measure subsided, and to keep the motions relax so as to avoid, as far as possible, any undue strain upon the sphincter or the levat ani.

Injuries of the coccyx are very frequently followed by persistent pain, an great tenderness of skin over the region supplied by the lower sacral nerves. Th is especially the case in women, though it is not confined to them. Sometimes can be traced to gouty or rheumatic inflammation of the fibrous tissue surroun ing the bone, and it may be relieved by iodide of potash, and by counte irritants; but in many instances it is rather a sign of uterine derangement, an nearly always it becomes worse at each menstrual period. In the worst cases it i necessary to provide the sufferer with a circular cushion, so that the tuberosities o the sch[illegible] may sustain the whole weight, and the coccyx lie, as it were, buried Subcutaneous section of the tissues around the bone and excision of the bon itself have been performed, when the distress was very great, but not always wit success.

## Fractures through the Pelvic Girdle.

When the [illegible] gives way at the weakest spot, rather than at the [illegible] fracture nearly always passes across the bone at the [illegible] and then if the force continues, at or near the [illegible] of the opposite side. Sometimes, when the force [illegible] fracture is almost symmetrical, the whole of the body o [illegible] from the rest, and both the articulations opened up [illegible] is impossible at once; more often the [illegible] from the extreme shock, the intense pain [illegible] separate or bring together [illegible] the neighbouring viscera. The [illegible] either in the superficial or the deep

face of the triangular ligament; in the former case the urine is extravasated into the scrotum, in the latter into the deep cellular tissue of the pelvis. The bladder, however, may be ruptured, the rectum, or even the contents of the abdomen severely injured, and the large vessels torn across. The injury, even when it is not complicated in any way, is always serious; and as the soft parts and the viscera are generally torn, crushed, or wounded by splinters, the prognosis in accidents of this kind is most unfavorable. So far as the fracture itself is concerned, very little is required; the part must be kept at perfect rest and over-examination carefully avoided, but the condition of the viscera must be ascertained with the least possible delay.

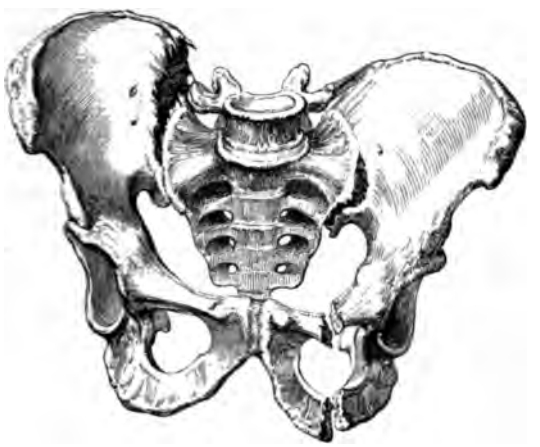


FIG. 140.—Fracture of Pelvis.

## FRACTURES OF THE FEMUR.

### I. THE UPPER EXTREMITY.

These were divided by Sir Astley Cooper into (1) fractures of the neck entirely within the capsule, (2) fractures at the base of the neck where it joins the trochanters, external to the capsule, and (3) fractures through the trochanter major, to which may be added (4) separation of the epiphyses. As, however, wholly extra-capsular fracture of the neck of the femur is an anatomical impossibility, so far, at least, as the front of the bone is concerned; and as this does not take into consideration the question of impaction (on which repair depends to a very great extent), it seems better to divide them into—

(1) Impacted fracture.
(2) Non-impacted fracture, of which there are two varieties:—
  (*a*) Intra-articular, wholly within the joint; and
  (*b*) Through the line of attachment of the capsule, at the base of the neck, partly within, partly without.
(3) Fracture through the trochanter.
(4) Separation of epiphyses.

It is true that a certain number of cases cannot be grouped under any one of these, but it holds good for the vast majority. They are to be regarded as types of common occurrence, presenting perfectly definite symptoms, and requiring entirely different methods of treatment.

It is as well to leave impacted fractures until the other forms have been considered.

#### *Intra-articular Fracture.*

This is peculiar for several reasons: it is very rare under fifty years of age, very common afterward; it is produced by exceedingly slight degrees of violence; it is more common in women than in men; and unless it is impacted, or the fragments are in some way held together, bony union never takes place. The line of separation lies wholly within the capsule, immediately below the head. If the force acts vertically the fracture is stated to be generally oblique; if from in front, transverse. Occasionally the under surface only gives way, the tissue at the upper part of the neck being bent rather than broken. When it is impacted the compact tissue on the under surface of the neck is driven into the cancellous substance of the head.

This may be explained in great measure by the structure of the part and the changes the bone undergoes as age advances.

The angle which the neck of the femur forms with the shaft is commo stated to be about 128° in the adult, and to diminish gradually in old age; women it is less than in men, and certainly the smaller it becomes and the n nearly it approaches a right angle, the more likely it is to give way. It is true, however, that this change is invariably associated with age. In many people the angle of the femur is quite unaltered; and, on the other hand, in amining the bodies of well-developed adults without a sign of rheumatoid arthrit I have on several occasions found the top of the trochanter higher than the he and this rotated so far that a flattened facet was developed on the front surfa corresponding to the tendon of the ilio-psoas.

The changes in the substance of the bone are more constant, but even the are proportionate rather to the amount of disuse than to the years of the patient. The cavity of the shaft extends upward with the cancellous tissue of the neck; the trabeculæ are thinner and softer, the bone itself is infiltrated with fat, and the compact layers on the exterior waste, until, in extreme cases, they are almos translucent. When this is far advanced it is scarcely surprising that a very sligh strain is sufficient to break it across.

The causes are always of the most trivial description. Sometimes it is a sudden vertical shock, as in slipping from off a curb-stone; in other cases it is a twist, as when in walking the inner side of the great toe catches against a fold o the carpet; the ilio-femoral band acts as the fulcrum of a lever; the leg is th long arm, the neck the short one; the head of the bone cannot move, the liga ment is much too strong to yield; so if the force is severe and sudden enough the short arm must break across at its weakest spot. Even turning round in bed will sometimes do it. In a third set the bone is broken by a fall upon the trochanter, and then there is often impaction; the thinnest part of the neck give way, and a continuance of the force drives the compact tissue upward and inward into the cancellous substance of the head.

**Signs.**—No attempt should ever be made to elicit crepitus, and manipulation of all kinds should be avoided as much as possible. The fragments at first are close together, and the only hope in obtaining union lies in keeping them there; any movement that would cause crepitus is sure to separate them.

**Displacement.**—The direction is nearly always the same, but the extent is very variable. The neck of the femur is invested, especially on its under surface by dense bands of fibrous tissue, which pass upward from the line of attachmen of the capsule to the margin of the head. These are the reflected fibres whic form a kind of periosteum for the neck and convey to the head its most importan vessels. In intra-articular fracture they rarely give way at the time of the acciden and partly from this, partly because the capsule is not torn, much separation of the fragments is unusual. The muscles that pass from the trunk to the thigh pu the femur upward and inward toward the middle line, so that the trochanter sin in and the limb is slightly shortened, but the amount of this rarely excee three-quarters of an inch. After two or three days, however, when, owing to th exudation that takes place, all t fibrous tissue is infiltrated and so ened, it often increases to an in and a half, or even two inches, unl care is taken to prevent it.

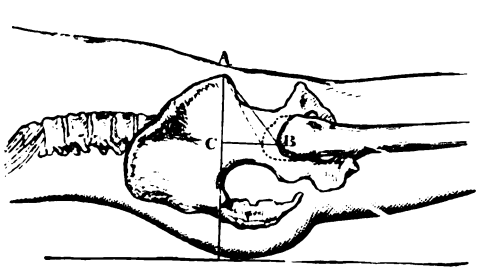



FIG. 141.—Bryant's Triangle. C B, test-line for fracture or shortening of the neck of the thigh-bone.

As accuracy in measureme is very essential, various metho have been devised for estimati the amount of alteration. Whic ever plan is adopted, care must taken that the position of the tw limbs is absolutely symmetrical; t

least deviation is sufficient to vitiate the result completely. A rough guess may be made by comparing the position of the two malleoli, having first made sure that the body is perfectly straight, and that the pelvis is not tilted. Measurement, either by means of tape, or better, with a sliding graduated rod, from the anterior superior spine of each side to the internal malleolus, is more accurate; but neither of these methods can prove where the shortening is. To effect this three different plans have been recommended: Nélaton's line, Bryant's triangle (Fig. 141), and Morris' bi-trochanteric measurement.

Nélaton's test consists in stretching a tape from the anterior superior spine of the ilium to the most prominent part of the tuberosity of the ischium. In the healthy adult the top of the trochanter never comes above this; if it does, the neck of the bone must have been shortened either by disease (rheumatoid arthritis or rickets) or by fracture. Bryant's triangle is made up of the perpendicular line

FIG. 142.—Intra-articular Fracture of Neck of Left Femur. No union has taken place; the neck has been absorbed; and the under part of the head glides up and down a polished surface corresponding to the anterior inter-trochanteric line.

FIG. 143.—Vertical Section through Upper End of Right Femur, from the same patient, showing the changes undergone in extreme atrophy.

from the anterior superior spine (when the patient is lying down); the line from the same point to the great trochanter; and a third drawn from this at right angles to the vertical one. The difference in the length of this third line on the two sides gives the amount of shortening. Morris' bi-trochanteric measurement compares the distance on each side from the median line to the top of the great trochanter. It indicates the inward displacement of the trochanter, and can only be taken satisfactorily by having a rod, graduated on each side from the middle, with two pointers sliding on it, so that when it is held over the body they may come into contact with the top of the great trochanter.

The appearance of the limb is very characteristic. It lies on its outer side, completely everted from the hip to the foot, with the knee slightly flexed; there may be a slight swelling in front over the hip-joint, due to the rotation of the lower fragment; the trochanter is sunken inward and drawn nearer the anterior spine, and there is from half an inch to an inch of shortening. There is no

superficial bruising or contusion; the trochanter is not thickened, and though it is painful when pressed upon, the pain is not like that of fracture through the base of the neck. The most tender spot is generally on the inner side of the thigh, about the insertion of the ilio-psoas or a little lower down. In some mild cases the patient is able to raise the heel from the bed, probably because the reflected fibres are intact or the fragments interlocked; more often the knee can be flexed a little, but any attempt to lift the leg fails completely. In a few exceptional cases there has been inversion of the foot. The eversion is due mainly to the weight of the limb; at least there is no doubt this is sufficient to cause it, though possibly the contraction of the ilio-psoas may assist (the short muscles attached to the great trochanter when the neck is broken would scarcely have any rotatory power); inversion, when it is present, must be produced by the direction of the violence that caused the fracture, and is probably kept up by the accidental locking of the fragments. In most cases the fascia lata on the outer side of the thigh, extending from the crest of the ilium to the head of the tibia, is distinctly relaxed, both above the trochanter and again above the knee joint.

Manipulation should be avoided as much as possible, but when it is really necessary for the diagnosis extension readily restores the limb to its proper length, and often, at the same time, gives rise to the sensation of crepitus, especially if the limb is rotated inward at the same time. Further, if the trochanter is grasped while this is being done, it clearly does not move through the same range as the other. Movement in all directions is abnormally free and very painful.

The constitutional disturbance in these cases is always slight at first; there is no fever and but little shock, but very often the patient never really rallies, the circulation remains feeble, the heart's action never recovers, the mind begins to wander, and congestion of the lungs, retention of urine and cystitis, or bed-sores, make their appearance in spite of every care. The prognosis, therefore, is always serious, especially in the aged.

**Repair.** — Union by bone probably never occurs unless the fracture is impacted. The broken surfaces are not in contact. Even if the action of the muscles and the weight of the part could be set aside, the distention of the capsule, partly from hemorrhage, partly from exudation, would be enough. Further, the head is often rotated in its socket, so that it no longer faces the broken surface of the neck; and as its blood-supply is cut off, no callus is ever found on the upper fragment. As Astley Cooper pointed out, most of the vessels that supply this part of the bone enter the neck on its under surface, and, of course, are torn; recently, too, it has been shown that the artery running in the ligamentum teres does not enter the bone at all. The blood-vessels in the neck probably dilate, because, in a large proportion of cases, this part of the bone is completely absorbed. The main bond of union is the capsule, which becomes enormously thick. Sometimes there is a certain amount of fibrous tissue formed between the fragments, passing from the under surface of the neck, and also from its cancellated structure, to the head; but in many there is no union at all, the surfaces become hard and polished, the neck disappears, and the head of the bone rests on the lesser trochanter, or spurs are thrown out round the base of the neck to catch the rim of the acetabulum. Many patients after accidents of this kind remain almost bedridden, or can only get about with assistance; others, especially if they are not corpulent, can lay aside their crutches after a time and walk with a stick—a few can dispense even with this; but, in spite of a high heel to compensate for the shortening, a certain amount of lameness is always left.

**Treatment.**—This must be guided entirely by the condition of the patient. Many old people never really lie down at all, and to keep them on their back by means of a long splint would inevitably bring on congestion of the lungs. Astley Cooper recommended that they should be propped up in bed, with the limb supported by pillows in the most comfortable position, for ten days or a fortnight until the pain in some measure had subsided; then they should sit up every day in a high chair, so as to avoid flexion of the limb, and begin to use crutches a

[illegible]on as possible, bearing a little more weight upon the foot each day, until the [illegible]psule had become sufficiently strengthened. In the meantime water-cushions [illegible]st be used freely so as to avoid the occurrence of bed-sores; the most scrupulous [illegible]anliness must be observed, especially as urinary trouble, partly from age, partly [illegible]om the confinement in bed, is very common; and the skin must be sponged [illegible]ith spirit every day to harden it. As soon as the patient begins to sit up, the [illegible]mb must be enclosed in a shield made of leather or felt, large enough to grasp [illegible]e pelvis and the thigh, running completely round the body and two-thirds round [illegible]e limb, as low as the knee. This should be made with straps and buckles, so [illegible]at, while it is able to hold the part firmly and give it sufficient support to protect it from injury, it may also be removed every few days for the purpose of attending to the skin.

In younger patients, especially when the amount of separation is not great, an attempt may be made to procure union between the fragments, though it is very unlikely that it will be osseous. A long splint must be applied to the outer side of the limb from the axilla to below the foot, as in fractures of the shaft, and a moderate weight attached to the leg, counter-extension being made by raising the foot of the bed. Particular care must be taken to correct the eversion; it is not sufficient for the foot to be merely straight, the great toe must be a little inverted, or when the bandages are removed it will be found that the correction is not sufficient. If possible, this must be kept up for six weeks, though if the patient's health begins to fail, or if, in spite of water-cushions, there is any fear of bed-sores, it is possible to do with a fortnight less; then the limb may be secured either in a Thomas's hip-splint or in a leather shield, and the patient allowed up on crutches, the foot being slung and not allowed to touch the ground for six weeks or two months more. Unless rheumatoid arthritis sets in, there is very little fear of the hip joint becoming unduly stiff.

In one or two instances the hip joint has been laid open from in front and the fragments wired together. The operation was successful and apparently osseous union followed; but cases in which such a proceeding could be recommended must be very rare.

### *Fracture through the Base of the Neck.*

This stands out in clear contrast to the former. The line of separation follows the intertrochanteric line in front; behind it is a little internal to it, so that the fracture is partly within, partly without the capsule; the whole of the neck is detached and the trochanter often comminuted. It may occur at any time, but is most common in adult life, and in men, because it is never caused but by an extreme degree of violence applied directly to the hip. A moderate amount of force breaks the bone across, drives one fragment into another, and leaves it impacted there; when it is more severe the wedge-shape neck splits the trochanter into pieces and frees itself again. There is a great deal of bruising all round the hip; the trochanter is widened, and often the fragments are quite loose; crepitus is always present; pain is very great; usually the shock is severe, sometimes even fatal; and the amount of shortening at the first is rarely under an inch and a half, and may be as much as three. Eversion is present in the vast majority, but occasionally inversion occurs, as it does in the intra-articular form.

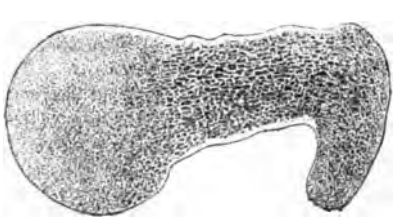


FIG. 144.—Horizontal Section through Neck and Trochanter of Femur, to illustrate the method of production of fracture through the base of the neck. The anterior layer of compact tissue bends when the posterior is driven into the trochanter, and then breaks. Probably partial fractures are of common occurrence.

Bigelow has shown, in reference to these injuries, the way in which the

fracture occurs. If a horizontal section is made through the neck and he the femur, the anterior layer of compact tissue is seen to be equally st throughout, perhaps rather stronger in the middle than elsewhere, owing to section passing through the tubercle; the posterior, on the other hand, abruptly in the cancellatous tissue of the trochanter. In a fall upon the hip part gives way first; the anterior layer splits more or less vertically, so that shaft is everted upon the neck; and if the force continues the posterior com layer is driven further and further into the trochanter until it splits into fragm

The difference in the mode of repair is equally striking. Union by bo almost invariable, and the amount of callus thrown out is often greatly in ex of what is needed. In these cases, therefore, every effort must be made to re the length of the limb and the position of the fragments as thoroughly possible. Very often it is of great advantage to give the patient an anæsthe the manipulation is painless; the broken surfaces can be adjusted more accurat the muscles are relaxed so that the limb can be extended to its full lengt once; and when consciousness returns, owing to the compression and exten to which they are subjected, there is not the same amount of spasmodic contr tion. The most efficient method is by means of a long splint and a weight, t amount employed being regulated in each case by the condition of the mu and the degree of shortening. If it is attached to the limb alone, and there friction against the bed-clothes, eight or ten pounds are usually sufficient, th in exceptional cases much more may be required. The rapidity with whic pair takes place depends upon the age of the patient and on the bruisin comminution to which the parts have been subjected. Generally the patien be allowed to get about at the end of four weeks with a Thomas's hip-splin a leather shield, or a firm spica (made extra strong in front and on the side), but no weight can be allowed upon the limb for at least six weeks or months more. Union rarely fails, but there is nearly always a certain degre lameness and shortening afterward.

### *Impacted Fracture of the Upper End of the Femur.*

This, again, is entirely different. There are two varieties, corresponding t the two described already, but they can rarely be distinguished from each other and, as they require precisely the same treatment, it is doubtful if there is muc advantage in attempting to do so. In the one the line of separation follows th base of the neck, and this is forced into the substance of the trochanter until it is fixed there (Fig. 145); in the other the fracture is immediately below the cartilage, and the under surface of the neck is driven into the cancellous tissue of the head (Fig. 146). The former is not confined to any age and sometimes may be diagnosed from the condition of the trochanter; the latter (the intra-articular form) rarely occurs except in old people, but it is seldom possible to distinguish one from the other. The important feature is the existence of impaction.

The cause is always direct violence, a fall or a blow upon the hip. The symp toms are almost the same as those described already, but they are not nearly so marked. The shortening is rarely more than half, or at the most three-quarters of an inch; and so long as the impaction continues it does not vary. There may be in version in this as in the other fractures, but it is very rare; the limb is either straigh or everted, and it is not possible to rotate it inward, as it is when the bone is n impacted. Sometimes the patient can lift the limb from the bed; walking, eve is possible; and Astley Cooper mentions the case of a man who went about four days and passed inspection before the impaction gave way. Crepitus a undue mobility of course are wanting; while the amount of pain and the severe of the shock naturally vary with the nature of the accident. The condition the fascia lata on the outer side of the thigh, whether it is relaxed or n is in many cases the only sign by which it is possible to distinguish betwe impacted fracture of the neck of the femur and a severe contusion of the

n old or rheumatic patient. Sometimes even this fails, and then the diagnosis only be made by the length of time that it takes for the limb to recover.

The important point in these fractures is the presence of impaction. If this be preserved, repair by bone is fairly certain, with the minimum of deformity; it is broken down, in the one case there will be only ligamentous union, perhaps e at all; in the other the deformity and shortening will almost certainly be eased, and the period of confinement much lengthened. The limb must be dled with the utmost care, and any manipulation that is not absolutely neces- strictly avoided. For security's sake it should be bandaged to a long splint, if there is any fear of congestion of the lungs, fixed between sand-bags with a ght of two or three pounds attached, not for the purpose of keeping up exten- n, but merely to prevent spasmodic contraction. In three or four weeks' time Thomas's splint may be applied, or the limb encased in a shield or a spica, and patient allowed to get about on crutches with the foot suspended in a sling. horter time than this is rarely advisable; and if the injury is very severe, or the tient corpulent, it may be extended with advantage. The accident is a serious

FIG. 145.—Impacted Fracture through Base of Neck of Femur.

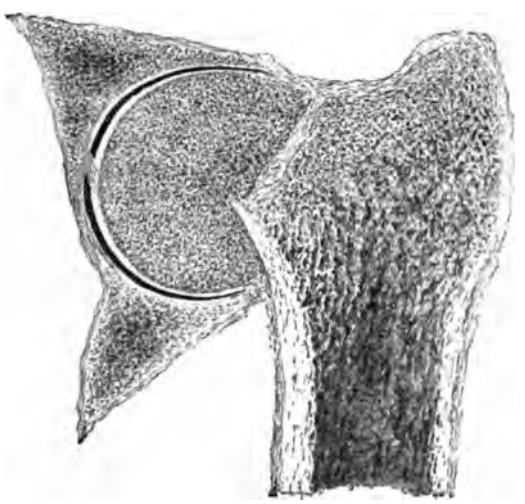


FIG. 146.—Impacted Intra-articular Fracture of Neck of Femur.

e, the weight and the leverage of the limb are very great, and it is rarely worth while running any risk. The shortening is easily compensated for, but if much tension of the limb is left the position of the foot is very awkward.

### *Fracture Through the Trochanter.*

Two forms of this have been described, but they are both rare. The first is merely a variety of the fracture through the base of the neck without impaction, the line of separation running obliquely through the trochanter a little further outward, so that one half remains attached to the head and neck, the other to the shaft. The symptoms depend upon the amount of displacement, which, unless the fragments become locked in some way, is generally very great. In one case the injury closely simulated dislocation on to the sciatic notch, but the presence of crepitus and undue mobility, the results of measurement in the flexed position of the limb, and the absence of the hollow in Scarpa's triangle, are sufficiently characteristic to prevent serious difficulty.

In the other variety the trochanter is detached from the rest of the bone

by direct violence. Several instances are on record, but as the patients young, in all probability they were examples of separation of the epiphysis (

FIG. 147.—Separation of Great Trochanter of Femur.

147). The swelling and ecchymosis may be so as to render diagnosis difficult; passive movement the joint is unimpaired, though very painful; crep can rarely be felt, owing to the way in which trochanter is pulled upward by the glutei and the rotators, and the length of the limb is unaltered. one case the broken surfaces were held together by fascia, which was not torn. Union, unless this is served, is almost sure to be fibrous, and for some t at least there is considerable loss of power over limb.

Separation of the epiphysis forming the head the femur may occur, but it has not been prove The symptoms would be the same as those of the intra-articular variety.

**Diagnosis.**—The diagnosis of fracture of the neck of the femur must be made from sciatic dislocation, impaction of the head of the bone into the floor of the acetabulum, fracture of the lip of the acetabulum, and contusion, especially in cases of rheumatoid arthritis. If there is the least doubt, the examination should be completed under an anæsthetic; to say nothing of the pain, it is almost impossible to manipulate the thigh of a muscular adult satisfactorily unless the muscles are relaxed.

1. *Sciatic Dislocation.*—The difficulty is due to the fact that in this form of injury the limb is often almost straight, and retains (especially at first) a very unusual degree of mobility; and also that the head of the bone can rarely be felt. Unless, however, the patient is very stout, an empty space can always be made out in Scarpa's triangle; the femoral vessels can be felt to dip down suddenly; abduction of the limb when it is flexed at a right angle is impossible, and the measurement of the length of the thigh, when the hip is in this position, shows very considerable shortening.

2. *Impaction into the Floor of the Acetabulum.*—This is a very rare accident, but on several occasions the mistake has occurred. The injury is produced in the same way; the violence is extreme and the amount of bruising sufficient to conceal everything. Movement may be very free, probably owing to the extent to which the bone gives way. The chief distinction is the extreme inward displacement of the trochanter; in addition there may be signs of injury to the innominate bone and it may be possible to feel the head of the femur through the rectum or vagina.

3. *Fracture of the Lip of the Acetabulum.*—When the upper and back part chipped off, the head of the bone slips out of the cavity and rests on the dorsum almost in the position of a dislocation. In one case under my care the displacement was exactly that of a sciatic dislocation, and was reduced as such, but immediately returned, and when the limb was manipulated the head of the bone could be easily felt above and behind the trochanter.

4. *Severe Contusions.*—In these the difficulty is very much greater, and if the limb is shortened and everted from old rheumatoid arthritis; if (as is often the case) the trochanter is thickened, and, owing to the disappearance of the articular cartilage, there is a certain amount of crepitus on movement, it may be impossible to feel certain until a sufficient length of time has elapsed for the muscles to recover. The limb lies perfectly helpless and everted; the muscles cannot act, owing to the way in which they have been bruised, and it is impossible to say whether the whole of the shock has been expended on the soft tissues, or if the bone has suffered too. Not improbably in many of these cases the neck is splintered on its anterior surface, though it may not actually be broken across. The history is of little service, supposing it could be relied upon; the existence of rheumatoid arthritis would not in any way preclude fracture. The only distinguishing sign is the condition of the fascia lata on the outer side of the thigh; if the shortening

dual (as from disease) this is tense; if sudden, it must be relaxed; but it must admitted that it is not always possible, even when the two sides are compared, make certain of the difference.

At a later period the diagnosis of contusion without fracture is occasionally ed in question, owing to a peculiar alteration that takes place in the substance the bone. It sometimes happens that, within a twelvemonth of an accident of kind, the neck of the femur almost disappears, the limb becomes everted and ortened an inch or even an inch and a half, the muscles waste, the movements e crippled, and the appearance is almost identical with that left after fracture of e neck. This is known as *interstitial absorption of the neck of the femur*. In ny of its features it closely resembles rheumatoid arthritis, and it is well known at this sometimes attacks a single joint, almost to the exclusion of the rest, especially after injury; but these changes are not unfrequently met with in young adults, who, at the time at least, show no other sign of this disease; and an alteration of a somewhat similar character is found occasionally in connection with other bones, the humerus, for example, after fracture. All that can be said is that injuries of this description are sometimes followed by profound alterations in the nutrition of the part.

### Fractures of the Shaft of the Femur.

These may be caused by direct or indirect violence, or by muscular action, and may affect any part of the bone from the lesser trochanter to the base of the condyles. In infants and children they are transverse and usually subperiosteal; in adults they are more frequently oblique, sometimes even spiral. Compound and comminuted fractures are not uncommon, but impaction is rare, except at the lower extremity.

**Displacement.**—The relative position of the two fragments is dependent mainly upon the direction of the fracture. When it is transverse and the periosteum is not torn, there is merely a certain amount of angular bending; in all other cases the lower part of the limb rolls outward, from its weight, until it lies completely upon its outer side, and is pulled upward toward the trunk by the contraction of the muscles. There may be as much as three or even four inches shortening in a muscular adult. The position of the upper fragment is not constant; it is generally rotated outward to a certain extent, especially if the fracture is high up, by the muscles attached to the great trochanter, but never so far as the lower one, and it is usually flexed and tilted upward, partly by the action of the ilio-psoas, partly by the pressure of the lower fragment against its under surface. When the fracture is immediately below the lesser trochanter I have known it tilted to such an extent that the broken surface projected underneath the skin upon the front of the thigh.

**Symptoms.**—The ordinary signs of fracture are well marked; the limb is shortened, everted, and absolutely helpless; undue mobility and crepitus are always present, and there is always extreme pain about the seat of injury. Ecchymosis, however, owing to the deep situation of the bone, often does not show itself for some considerable time, in many cases not at all. Sometimes it is difficult to make certain of the exact position and direction of the broken ends, especially if they are very oblique or driven deeply into the substance of the surrounding muscles, and it is never easy to appreciate the amount of comminution. The soft tissues rarely suffer to any serious extent in simple fractures, except when the injury is low down in the thigh; in those that are compound by direct violence, on the other hand, they are often hopelessly disorganized.

Union is generally sufficiently firm at the end of three weeks to allow the patient to get about on crutches with some fixed apparatus, but no weight must be placed upon the foot for at least ten weeks from the date of the accident, and in many instances, when the patient is corpulent or the fracture oblique, this time ded with advantage. Except in transverse fractures, shortening to

the extent of half an inch is so common, in spite of every precaution, that it [illegible] be regarded as the rule; sometimes it is even worse than this, without its be[illegible] possible to say that the case has been treated badly. Delayed union is not unco[illegible] mon, and false joint may occur, especially when the fragments are oblique or [illegible] driven into the muscles around.

**Treatment.**—The simplest and most useful method for all ordinary cases [illegible] a combination of Liston's (Fig. 148) or Desault's (Fig. 149) long splint, with e[illegible] tension by means of a weight attached to the limb. Counter-extension is ma[illegible] not with a perineal band, which is very apt to gall the patient, and in women [illegible] peculiarly objectionable, but by raising the foot of the bed, so that the body lie[illegible] on an inclined plane [and itself constitutes the counter extending force.] The splint must be sufficiently long to reach from the axilla to below the foot, the outer malleolus fitting into the hollow made to receive it, and sufficiently broad to be really on a level with the thigh; in cases in which the hips are prominent, the padding must be especially thick or the patient cannot lie straight, and there should always be a cross-bar screwed to the under surface at the lower end, to serve the double purpose of raising the heel well off the bed and of preventing any rotation of the limb. A flannel bandage is first placed round the foot and the lower part of the calf; and then a piece of strapping two inches and a half wide, and twice the length of the distance from just above the patient's knee to six inches below the sole, is fastened to the limb, so that the two ends lie one on each side, and the loop projects below the foot. If the strips are arranged obliquely, the outer end winding round the limb toward the posterior surface, and the inner to the anterior, the extension helps as soon as the weight is on, to correct the eversion of the limb. Transverse strips are then placed round the limb to hold this in position, the centre of each corresponding to the posterior surface of the leg and the ends crossing obliquely in front, until the whole is covered in from the middle of the calf to the condyles of the femur. The loop is held open with a wooden stirrup, which is perforated in the centre to allow of a cord being passed through and is wide enough to prevent any pressure upon the malleoli, and the weight suspended from the other end of the cord by means of a pulley at the foot of the bed. The amount depends upon the degree of shortening and the strength of the muscles, but eight or ten pounds are usually sufficient (Fig. 150).

Fig. 149.—Desault's Splint.

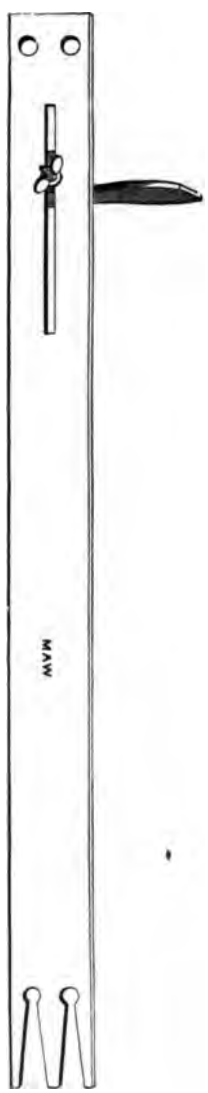


Fig. 148.—Liston's Splint with Sliding Foot-piece

If the patient is under an anæsthetic the splint may be bandaged on at

; in other cases it is sometimes advantageous to wait until the next day, when fragments have resumed their normal situation; the part in the meantime is pt steady by means of sand-bags. The long splint is fastened to the outer e of the limb, from the foot to above the knee, beginning with figure-of-eight rns, wide enough to pass through the notches at the lower end of the splint d to come well above the ankle; if any pressure falls upon the back of the el, a sore is sure to form. In fractures near the middle of the shaft it is dvisable to place a splint behind the limb to maintain the natural arch of e bone; the inner and anterior surfaces may be covered with felt or with Gooch's splint, cut to fit the part, and fastened on with straps and buckles

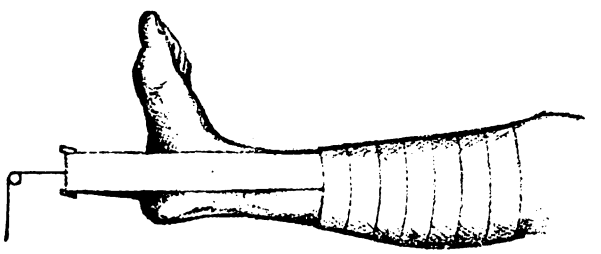


FIG. 150.—Mode of Applying Stirrup for Weight-Extension.

(Fig. 151). In other cases it is sufficient to carry the bandage up from the knee over the seat of fracture. In bandaging a fractured femur the turns should be carried from the outer side over the front of the limb down the inner one, as this is of considerable help in correcting the eversion. Finally the splint must be secured round the waist, either by means of a broad bandage, or a belt provided with straps and buckles, and bandages starched.

Liston's splint is made of wood four inches wide, and half an inch thick, long enough to reach from the axilla to six inches below the foot. The upper end is perforated for the attachment of a perineal band; the lower notched, so as to afford a better grip for the bandage. Desault's differs in having a foot-piece to fit

FIG. 151.—Liston's Splint Applied with Gooch's round Seat of Fracture.

on the outer side, in being hollowed out, and in being much wider at the upper end than at the lower.

At the end of a fortnight or three weeks, according to the age of the patient and the direction of the fracture, this may be replaced, either by a fixed apparatus of gum and chalk, a starched bandage with longitudinal strips of torn pasteboard, or, better still, by a Thomas's knee splint. This consists of a well-padded circle, fitted obliquely round the thigh as high up as it will go, two straight rods coming down from this, one on each side of the limb, and a small patten at the bottom, below the foot, to connect them together. If the stirrup has been well applied the long splint can be removed, a Thomas' splint fitted on, the weight cut off, and the cord fastened to the patten at the bottom without disturbing the limb in the least

(Fig. 152). In most instances it is advantageous to replace the cord by an elastic band, so as still to keep up a certain degree of extension, or the sides of the splint may be made so that the length can be altered at will. Anterior and posterior wooden or felt splints are necessary to protect the seat of injury, and the leg and thigh must be firmly bandaged to the side rods. As soon as this is secure the patient may be allowed to get about on crutches, with a patten under the opposite foot; but, though the whole of the weight would be transmitted directly from the pelvis to the ground, it is not advisable to let him rest upon the splint patten for some weeks longer; the leg should hang from the hip-joint as a mere appendage. In some cases Thomas's splint is used from the first, but it is difficult to obtain the requisite amount of extension without galling the patient; after being kept steadily on the stretch for two or three weeks, the tendency to contract on the part of the muscles is very much diminished.

In fractures below the trochanters another plan must be adopted. Extension in a straight line does not in any way correct the deformity, and as it is impossible to influence the upper fragment materially, the lower must be adjusted to it. This is accomplished either by laying the patient upon the injured side, and flexing the thigh upon the abdomen as recommended by Pott, or by making use of a double-inclined plane. The latter is the more comfortable; the patient can be propped up in bed so as to relax the ilio-psoas still more, and there is less risk of bed-sores. A MacIntyre splint answers better still, and is less cumbersome. Whichever plan is adopted, extension is made from the lower half of the thigh by means of a stirrup and a weight suspended over a pulley at a convenient angle (Fig. 154).

In cases in which there is a wound on the posterior surface, or the hip or knee is ankylosed in an awkward position, an anterior splint, either Hodgen's or Nathan Smith's, may be used. The former of these consists of two parallel metal rods, long enough to reach from the groin to below the foot, held apart from each other by cross-bars. The limb is suspended from between these by cotton sacking, or broad strips of flannel, so that it rests and makes a bed for itself

FIG 152.—Thomas' Brace Splint with Stirrup-Extension. The anterior and posterior splints on the thigh and the bandaging are not represented.

FIG. 153.—Badly United Fracture of Femur.

a kind of trough (Fig. 155). The foot is fixed by a stirrup to the cross-bar the end, and the whole is slung from a pole over the bed at such an angle that certain amount of extension is kept up, the weight of the body acting as a unter-extending force. The knee joint must be kept nearly straight. Nathan ith's is either formed of a similar framework with the rods closer together, or

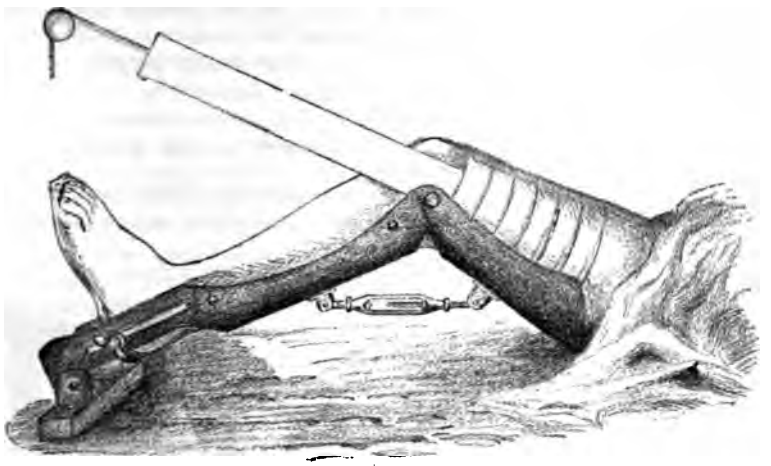


Fig. 154.—MacIntyre Splint with Weight-extension from the Knee in Fracture of the Femur below the Trochanter.

of a single flat median bar. The limb is bandaged directly to its under surface, so that it must be bent to fit accurately, and then it is suspended in the same way. When properly adjusted these splints are exceedingly comfortable, but they are very difficult to arrange (suspending hooks should be made so that they can be fixed at any point); they do not secure the same degree of immobility, or maintain extension so well, and it is very difficult to prevent eversion with them.

Transverse fractures of the shaft in children may be treated in various ways. In very young infants, where the thick periosteum is probably intact all round, it is sufficient in many cases merely to lay the child upon a pillow on its injured side, with the hip and knee flexed. As a rule they lie remarkably quiet, and though the bone may not be perfectly straight, the angle is so slight, and the subsequent changes so rapid and extensive, that in a year or two it is scarcely perceptible. Union is fairly firm in ten days or a fortnight. In those a little older, vertical suspension of both legs is more satisfactory; a miniature stirrup is fastened on to each in the ordinary way; the cords are

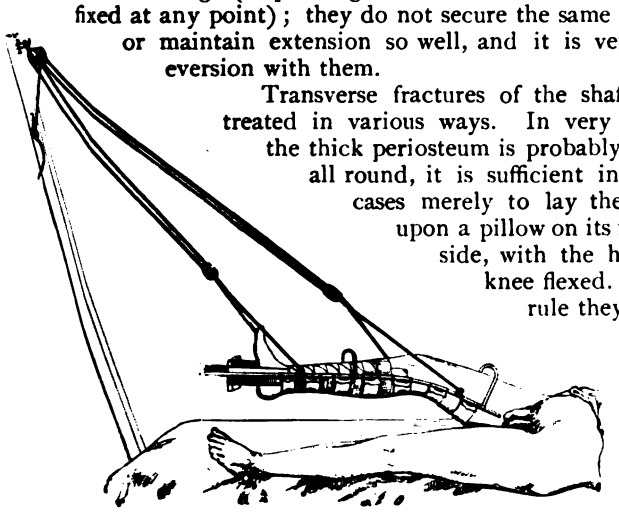


Fig. 155.—Dr. J. T. Hodgen's Suspension Splint, as used at Guy's.

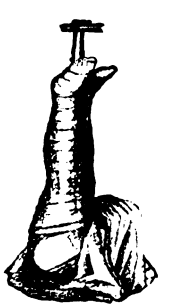


Fig. 156.—Plaster Bandages and Vertical Extension for Fracture of Femur in an infant.

passed over two pulleys attached to a cradle or a horizontal bar over the child's body, and a weight is suspended from each just sufficient to keep the leg straight in a vertical position. A starched bandage is then placed round the thigh. The child soon becomes accustomed to the constraint, and the bandages remain dry and clean to the last. Bryant's splint, which is made of two long cords, one on either side of the body, connected together by an arch over the trunk and a bar below the feet, is especially useful in the case of older children. Extension can be applied by a weight to the injured leg; it is impossible for the child to twist its body round, and the limbs are kept exactly parallel.

### Fractures of the Lower Extremity of the Femur.

These may be classified in the same way as fractures of the lower extremity of the humerus. The bone may be broken across altogether above the knee-joint,

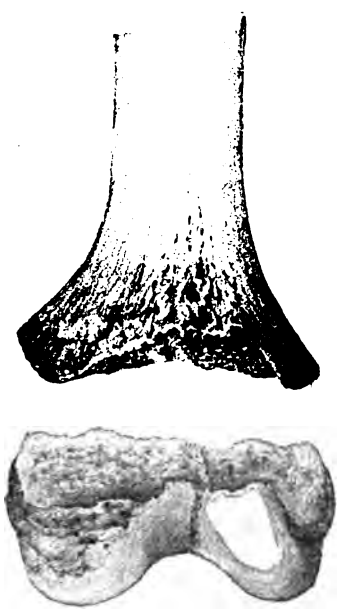


Fig. 157.—Shaft and Epiphysis of Femur Separated by maceration. The epiphysis had been split in two about a year before the limb was removed, and union across the epiphysial line was osseous.

Fig. 158.—Fracture of Lower End of Femur with Displacement of Upper Fragment Backward. About a year after the accident the projecting end wore a hole in the popliteal artery and gave rise to an arterial hæmatoma.

supracondyloid; in addition to this the lower extremity may be split vertically in two, by the wedge-like action of the patella, T-shaped; one or other condyle may be detached; or the epiphysis may be separated. Impacted fractures are not uncommon, the lower end of the upper fragment being driven into the cancellous tissue of the other with sufficient force to become fixed in it, but not sufficient to break it into pieces. The lower end of the femur may be split vertically by the impact of the patella, without any transverse separation (Fig. 157).

#### *Supra-condyloid and T-shaped.*

These may be produced by direct or indirect violence; in the latter case the bone gives way at the junction of the compact tissue of the shaft with the expanded lower extremity; impaction is not unusual; and, if the force is ve

severe, the lower fragment is split into two (or even more pieces), the fracture assumes a T-shape, and the knee joint is opened up. In the supra-condyloid form there is peculiar danger from the position of the popliteal vessels. The fracture is generally oblique from above downward and forward; the gastrocnemius, pulling on the lower fragment, causes it to rotate; the fractured surface is directed backward, the normal anterior one upward; and if any extension is made upon the leg the vessels are almost certain to be compressed, perhaps even torn.

The same thing occurs when the displacement is in the opposite direction, if the lower end of the upper fragment comes in contact with the artery (Fig. 158). The synovial membrane of the knee joint may be torn under the quadriceps tendon so as to communicate with the fracture, even when there is no vertical fissure running down.

**Signs.**—Shortening, deformity, pain, and swelling are so conspicuous that, even if the fragments are impacted, there is little difficulty in the diagnosis. If they remain loose, crepitus and undue mobility are present as well. When the knee joint is involved the synovial cavity becomes distended with blood; if the condyles are separated, they can be made to work backward and forward upon each other by pressing on them alternately; and there is an increase in the transverse measurement of the part. When the popliteal artery is torn, or wounded, an immense swelling forms with great rapidity in the popliteal space, filling it up completely, and the limb becomes cold and pulseless; if it is merely pressed upon, the temperature of the limb falls more gradually, but in spite of the collateral circulation the same result generally ensues.

**Treatment.**—This depends to a great extent upon the direction of the fracture and the amount of injury done to the knee joint. Shortening is very common, unless the fracture is transverse, and nearly always there is some impairment of movement, partly owing to the difficulty of restoring exactly the outline of the articular surfaces, partly from the formation of adhesions. The condition of the posterior tibial artery requires even more than ordinary attention. Liston's long splint and weight extension from the leg may be used, if the upper fragment has a tendency to backward displacement; in all other cases either the limb must be placed on a double inclined plane (or a McIntyre splint), or the tendo-Achillis must be divided. The latter is preferable, as, owing to the small size of the lower fragment of bone, it is almost impossible to make satisfactory extension from it with the knee flexed. If the knee joint is involved, the distention of the synovial sac must be reduced as soon as possible by cold, pressure, and even aspiration, though this should only be resorted to when the case is really urgent. Then the fragments must be replaced by manipulation, and fixed by pressure, taking care to cover them with a thick even layer of cotton-wool. Passive motion of the joint should be commenced not later than the end of the fourth week. If the popliteal artery is wounded, an attempt may be made to secure the two ends by ligature; but very often the vein is injured as well, or the fracture communicates with the joint, and either gangrene sets in or the knee is disorganized to such an extent that the limb has to be amputated.

### *Separation of a Condyle.*

It occasionally happens as a result of direct violence, or even it is said from forcible rotation, that one of the condyles is detached from the rest of the bone without the shaft being broken across. The symptoms depend upon the amount of comminution; the joint becomes distended with blood, generally at once, but in one case under my care this was not marked in degree for several hours; the length of the limb is not altered; pain on pressure is very great; and crepitus and undue mobility are usually distinct. A fixed bandage, with a thick layer of cotton-wool over the joint, should be applied as soon as the fragments can be manipulated into position; but as absorption proceeds it will probably require to be replaced in

the course of a few days. Passive motion should be commenced not later t the third week.

*Separation of the lower epiphysis* is not an uncommon form of accident can only occur under twenty years of age, and is rarely met with over sixt Generally speaking it is produced by indirect violence, forcible wrenching twisting, but it may be caused by direct. The knee joint is almost certain to involved, though it is anatomically possible to separate the epiphysis without op ing the synovial membrane. The symptoms are almost the same as those of t supra-condyloid variety, from which it can only be distinguished by the age the patient, the absence of true crepitus, and the position of the adductor tubercle The displacement and the treatment are the same, though owing to the concav shape of the upper surface of the epiphysis there is not the same tendency t backward rotation of the lower fragment.

## Compound Fractures of the Femur.

These may occur either from direct or indirect violence. The latter are no common, partly because the bone is situated at such a depth, partly because it i so impossible for a patient with a broken thigh to try to stand; most of them occur at or near the lower third, and frequently they involve the knee joint.

When they are due to direct violence, the injury to the soft parts is generally so extreme that there can be little hope of saving the limb, especially as the skin is not unfrequently destroyed far above the point at which the bone is crushed. The only question is when amputation should be performed. In the case of the upper part of the femur, this operation, when primary, affords so little hope, that, unless in exceptional instances, it is practically abandoned; hemorrhage must be checked, not merely that from the main artery, which seldom bleeds, but the capillary oozing, for this, though almost imperceptible at any given moment, is very serious from its persistence; putrefaction must be prevented, especially in the region of the bone, where it is exceedingly prone to occur; and every effort must be made to restore the patient's temperature and tide him over the shock. When reaction has fully set in, the mangled part may be removed and the stump trimmed without so much risk. If the injury involves the lower half, amputation may be performed as soon as the patient is in a fit state to bear it; but, unless it is done immediately after the accident, so that the operation is really primary, it is better to treat the case in the same way as a fracture of the upper half, and wait till the second or even the third day.

In fractures that are compound by indirect violence the prospect is much better, and even when the knee joint is involved the limb can usually be saved. The treatment must be guided by the age and constitution of the patient and by the nature of the injury. A mere puncture may be dusted over with iodoform and sealed beneath an absorbent dressing, the wound and the bone, if it protruded, having first been thoroughly cleansed with corrosive sublimate or some other antiseptic. A larger opening should be carefully explored with the finger, washed out to its utmost recesses, and either drained with counter-openings or left gaping to a certain extent. If the bone is comminuted, any loose splinters may be removed, and if the fragments are much displaced they may be sutured together, but this is rarely possible in the case of the femur without enlarging the opening very considerably. Wound of the femoral artery does not of itself require amputation in a case of compound fracture; injury to the vein appears to be more serious.

The same line of treatment must be pursued when the fracture extends into the knee joint, but it must not be forgotten that, though the opening on the surface may be small, the real size of the wound is equal to that of the synovial membrane. Every effort must be made to prevent inflammation; the part itself must be thoroughly cleansed; the wound, if more than a puncture, washed out

[illegible] the bottom with an antiseptic and drained; the limb placed upon a Macintyre splint; cold and gentle pressure applied to the joint; and an ice-bag laid on the femoral artery if there is the least sign of heat in the limb. If, in spite of these precautions, the joint swells up and becomes tense, and if the skin over it becomes red and œdematous, and the patient's temperature begins to rise, free incision should be made on each side into the joint and thorough drainage carried out. Even then the articulation may recover, though suppuration, with destruction of the cartilages and ankylosis, is a more probable result; and secondary amputation may be required to prevent the patient sinking from exhaustion.

## FRACTURES OF THE PATELLA.

These are nearly always the result of muscular action; occasionally they are produced by direct violence. In the former case the line of separation is always transverse, though it may run across any part of the bone; the fascia is torn to a greater or less extent; the amount of separation is generally considerable; and union by bone is the exception, not the rule. In the latter the fracture may be stellate, vertical, transverse, or comminuted; the fascia covering it and attached to the sides is not torn; the amount of separation between the fragments is not exceptional, and union nearly always takes place by bone (Figs. 159 and 160).

FIG. 159.

FIG. 160.

Transverse and Stellate Fractures of Patella.

### FRACTURE BY MUSCULAR ACTION.

The frequency with which this takes place is accounted for by the anatomical relation of the part. When the knee is flexed, the lower half of the patella rests upon the prominent portion of the condyles of the femur, the upper is entirely unsupported, and the plane of the

FIG. 161.—Section through Knee after Fracture of Patella, showing Displacement.

FIG. 162.—Knee in a case of Fractured Patella.

bone is almost at right angles to the direction of the quadriceps. If this muscle suddenly contracts, the whole of the strain falls upon one spot, and the bone gives way just as when a stick is snapped across the knee. The patient is

conscious of something breaking before he falls, and it sometimes happens t in the desperate effort to save himself, the other patella snaps across as w I have known this occur to a man in the first stride of a race.

**Displacement.**—The amount is very variable, and depends upon the l ation of the fascia; if this does not give way there is no separation. At the instant it is caused by muscular contraction, and it is often made worse by atte ing to stand or walk. Afterward the broken surfaces are forced asunder by effusion into the joint, and the separation is kept up by clotting of the blood between, or by tilting of the fragments owing to the insertion of the tendon i the edge of the anterior surface of the bone; or by shreds of fascia and so times even the skin being driven down into the gap. In old cases the upp fragment is often practically immovable, either because it is fixed to the femur because the muscular substance of the quadriceps has undergone degeneratio The outer edge of the patella is longer than the inner, so that when the tw fragments are brought together they do not meet on the inner side, and in cases fibrous union the inner part is usually longer than the outer (Fig. 162).

**Symptoms.**—There is rarely any difficulty in the diagnosis, though occ sionally when there is a thickening in the bursa over the bone, or extravasation blood into the periosteum, a deceptive transverse depression may be felt. As rule there is wide separation, the fragments are distinct and can be moved fro side to side, or one can be tilted by direct pressure without the other; swellin sets in at once and assumes the shape of the synovial membrane of the join crepitus, of course, is not present unless the upper fragment can be pressed dow

FIG. 163.—Osseous Union of Transverse Fracture of Patella. From a subject in the dissecting room. There was no scar visible on the skin.

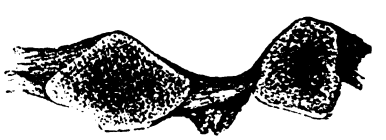


FIG. 164.—Fibrous Union of the Corresponding Bone on the Opposite Side.

and brought into contact with the lower; the loss of power over the quadriceps i complete in proportion to the separation of the fragments and the tearing of th fascia; in a very few instances the patient has been able to raise and extend th limb.

**Prognosis.**—Union may take place by bone, though this is rare, or b fibrous tissue, the broken surfaces being united directly to each other face to face or there is no true union at all, but merely a thickened layer of fascia passin over the anterior surface of the fragments from one to the other. In no case do the quadriceps, especially that part of the vastus internus just above the kn joint, completely recover. If there is good fibrous union, with not more th half an inch interval, the use and the strength of the limb are scarcely impaire when the fascia is the only uniting medium, though the interval may be small first, it is sure to elongate, until it may be as much as five and even six inc (Figs. 163 and 164).

Flexion is permanently impaired in many cases; in a few the knee remai quite stiff, and occasionally the upper fragment becomes attached to the femur.

As vertical fractures almost invariably unite by bone, and as in some f cases the amount of callus thrown out is so great as to interfere with the glidi of the patella on the femur, it is clear that the failure of union is due mainly the fragments not being in contact—they are kept apart either by the effusion, by being tilted, or by the fascia being pressed down between them and entangl by the broken surfaces; and the amount of callus formed is not sufficient

ridge the interval; none is thrown out by the articular surface, and very little by the cutaneous.

**Treatment.**—Where the effusion is only slight, and the fascia at the sides of the patella is not torn, there is little difficulty in maintaining the fragments in contact, especially if they are of equal size. The knee must be kept straight on an inclined plane, the hip slightly bent, and the whole limb encased in a starch bandage, carried in figure-of-eight turns over the knee right up to the groin. A short back splint or a firm pad in the popliteal space is advisable to make it more secure. The effusion rapidly becomes absorbed, the fragments are drawn together by the bandage, the amount of tilting is very slight, and the even pressure round the quadriceps checks any tendency to spasmodic contraction. No lateral movement of any kind should be allowed for at least six weeks, even to test the degree of union; little bony spicules are occasionally found shooting through the lymph from one fractured surface to the other, and all of these should be broken off at once.

In the majority of instances, however, something more than this is required. Every effort must be made to get rid of the effusion as soon as possible; not only does it force the two fragments apart, but it stretches the membrane, and makes it thick and stiff, so that it interferes with the freedom of movement afterward. Cold is of great service at first, but it can only check exudation, not assist absorption; pressure properly applied over a thick layer of cotton-wool is much more

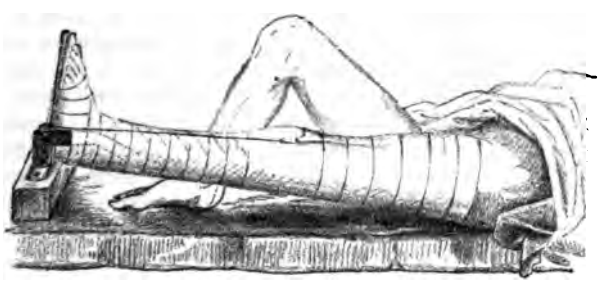


FIG. 165.—Transverse Fracture of Patella Treated by Extension from a Poroplastic Shield.

effectual; but if at the end of three days there is much left, the joint should be aspirated. It is true that, unless proper precautions are taken, this proceeding is attended with a certain amount of risk; and that sometimes it is impossible, owing to the density of the coagula, to empty the articulation completely; but many of the cases obstinately resist for such a length of time that nothing else is of any avail. The opening, which is best made above and to the inner side of the patella, should be valvular, and if a cannula is used it should be cleaned well first by boiling it in a solution of caustic potash.

Sometimes after this is done the fragments come into apposition almost of themselves; more often something further is required to bring them together. The simplest apparatus is a back splint, rather wider than the limb, and hollowed out to fit the knee. Two hooks are screwed into each side about eight inches apart, one above the joint, the other below; and two elastic bands are fastened to these, so as to loop over the limb in a figure-of-eight. The lower one passes above the patella, and tends to draw the upper fragment down; the upper one, crossing this, catches the ligamentum patellæ and forms a fixed point. The skin, which is very freely movable over the knee, should be stretched away from the seat of fracture as far as possible before this is applied, or it may be forced down between the broken surfaces. The chief disadvantage is the liability to tilting of the fragments.

A better plan is to mould a piece of thin poroplastic felt or thick moleskin over the front of the thigh, cutting it out so as to fit round the upper margin of

the patella, and leaving on either side a loop or a projection to which an elastic band can be attached. The limb should be fixed in a MacIntyre or a Thomas knee-splint, and the elastic bands drawn down, one on each side, and secured to the foot-piece. At the same time a strip of bandage or plaster must be carried over the upper fragment to prevent it rising. At the end of a fortnight or three weeks the whole limb may be incased in a fixed apparatus and the patient allowed to get about on crutches (Fig. 165).

If due precautions are taken, Malgaigne's hooks may be used with a fair degree of safety (Fig. 166); and, so far as mechanical reasons are concerned, nothing can answer better, especially if the instrument is divided longitudinally, so that there are two halves, right and left, which can be screwed up separately. The limb must be secured to a back splint, so as to keep it at perfect rest in complete extension; the fragments must be brought down to their definite position; and a minute puncture made with a sharp-pointed scalpel at the spot that the hooks are intended to penetrate. The two upper should be carried right down to the bone, and, as suggested by Treves, may be made use of to evacuate the fluid from the joint; the lower do not involve the synovial membrane. Then the hooks are inserted, the lower ones being fixed first, and screwed up until everything is in position. If there is any tendency on the part of the upper fragment to ride forward, it may be checked by carrying a tape round the limb and the splint, and tightening it up as required. The pain is very slight, not sufficient to require an anæsthetic; the fragments can be adjusted perfectly; and if the little wounds are dusted over with iodoform and kept dry and quiet, there is little risk of inflammation.* In former days there is no doubt this was not an unfrequent consequence. The hooks may be kept in for six or eight weeks without any ill consequence; but there is no advantage in retaining them for more than three; at the end of that time the limb is generally sufficiently secure to be enclosed in a fixed apparatus. The plan of fixing the hooks into crescents of felt or moleskin strapping, fastened to the skin above and below, does not present any advantage over other methods.

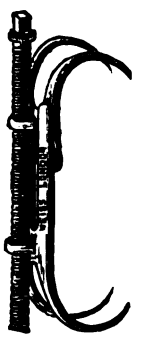


FIG. 166.
Malgaigne's Hooks.

Many other plans have been devised for bringing the fragments together by means of pins or hooks fixed in the bones. Transverse channels have been drilled through the two fragments from side to side, and wires or pins passed through. Longitudinal ones have been tried, without any incision other than that required to admit the point of the drill. Pins have been driven into the ligamentum patellæ and the tendon of the quadriceps, so as to obtain some fixed point. They have all succeeded, but they are none of them devoid of risk.

Laying open the knee joint, and converting a simple fracture into a compound one, has been strongly recommended, even in recent cases; and it is worthy of consideration in exceptional instances in which it is impossible, in spite of every endeavor, to bring the two fragments face to face. The risk, however, even with the strictest antiseptic precautions, is much too great; especially as in young and healthy subjects, firm fibrous union, leaving a strong and useful limb, may be reasonably counted upon without. A vertical incision, two inches in length, is made over the anterior surface of the bone with its centre opposite the line of fracture. The joint is opened freely; all blood-clots turned out; and then two holes are drilled obliquely, from the cutaneous to the fractured surface, so as not to involve the cartilage. A stout silver wire is inserted through these; a drainage tube passed through the deepest part of the joint upon the outer side; the fragments brought together; the wire twisted up and the ends cut off and hammered down. Others recommend a transverse incision above or below the line of frac

* The hooks as originally devised by Malgaigne were very sharply curved so that the point should not penetrate the joint.

ge, on the ground that if suppuration occurs in the skin wound the deep one is so liable to be infected. It is true that bony union has taken place in the majority of cases operated on; but suppuration has occurred in several, in spite of antiseptic precautions; ankylosis of a greater or less degree has followed in many; and in one or two the bond of union has broken down again and further operation has been required.

The only other plan that requires special mention is that first devised by Kocher. It consists in passing a stout silver wire completely round the patella. A needle in a handle (such as is used for sewing up a lacerated perineum, only longer, stouter, and with a wider curve) is passed through the ligamentum patellæ, through the tendon of the quadriceps and out through the skin. It is then threaded and drawn back again; the broken fragments are brought together; the wire twisted up, over something to protect the skin; and the openings dusted over with iodoform. The limb is then placed upon a back splint, and carefully bandaged, for three weeks. At the end of that time the wire is cut, drawn out of the wound, and the little ulcers that are left dusted over again with iodoform until they are healed. I have known this employed in a large number of cases without untoward result of any kind; and the union was always exceedingly close, though I am bound to confess it was not possible to prove in the majority that it was osseous.

The after-treatment of a case of fractured patella requires just as much care. It is not uncommon to find that the distance between the fragments, even though it is scarcely half-an-inch at the first, in a few months grows larger and larger, until it may be as much as five or even six inches. In the majority no doubt this is due to the fact that there is no true union at all; but in very many it is the result of allowing the joint to bend too soon and throwing an undue strain upon newly-formed fibrous tissue. In all cases of transverse fracture the limb should be thoroughly encased, without being touched, for at least six or preferably eight weeks; and then an apparatus must be worn, so that there can be no attempt at flexion for at least as many months. The best are made of leather, laced up at the sides, with an opening in front for the patella, and a steel rod behind, so that bending is impossible; but a very serviceable splint may be made from poroplastic felt, or even from gum and chalk. At first it should be left off at night only, and then by degrees more and more, until at the end of a twelvemonth it may be dispensed with altogether. For a time, of course, the joint is stiff, and the quadriceps wasted, but (with the exception, as already mentioned, of a portion of the vastus internus) this soon passes off; and if there is good fibrous union it does not stretch, no matter what strain falls upon it. Massage, hot douching, galvanism, and gentle passive motion may be used to expedite matters, but as a rule (unless the patient is gouty or rheumatic), the stiffness disappears at length of its own accord (Fig. 167).

FIG. 167.—Apparatus for Fibrous Union of Patella.

**Imperfect Repair.**—The question of operation in these cases rests upon entirely different grounds; union by ordinary methods has been tried and failed; and it depends upon the degree of utility the limb possesses, upon the strength and occupation of the patient, whether he should be recommended to get about with the support afforded by a knee-cap, or whether an attempt should be made to obtain firmer union. The operation itself is carried out in exactly the same way: the tissue between the broken surface must be removed thoroughly, and either the fragments drilled together or a wire passed round them after Kocher's plan; whichever is adopted it is essential that the apposition should be accurate. If an opera-

tion of this kind is attempted, it is advisable not to wait too long ; when quadriceps has once undergone degeneration, it is almost impossible to bring upper fragment down sufficiently ; the adhesions between it and the femur be torn, the tendon divided, and even V-shaped incisions made in the muscular substance above it, without its being possible to bring it close enough to effect good union.

Refracture occasionally takes place, the fibrous band tearing across, or bone giving way at a fresh place. If it is simple, it may be treated in the ordinary manner, and it is surprising how far recovery can take place, and how useful limb can prove ; if compound, the fragments had better be wired together at once. In one or two instances, in which the interval was too great, resection of the knee joint was performed in the hope of giving firmer support.

### Fractures by Direct Violence.

In these the fascia attached to the bone is seldom torn, and the degree of separation is slight, even when the joint is filled with blood. The treatment is the same as for transverse fracture without displacement ; but, as union is nearly always osseous, passive flexion of the limb may be commenced much sooner.

### Compound Fractures.

When the accident is the result of direct violence the injury is rarely confined to the patella : generally the other bones are involved as well, and often the soft parts are extensively destroyed. In former days amputation was regarded as inevitable for such injury as this ; at present, if the part can be thoroughly cleansed and thoroughly drained, a successful result may be hoped for, even when such an amount of bone is removed that practically it becomes a primary resection. If, however, the skin is extensively damaged, or if the popliteal artery or vein has been torn or punctured, there is no alternative.

Fractures by muscular action are occasionally compound, especially when the bone gives way for the second time. In one case under my care the skin was torn across from one side of the joint to the other ; but though the patient (who was a coalheaver) was not brought to the hospital for some hours after the accident, union took place by the first intention, without the least fever. If it is feasible the fragments should be wired together at once ; if it cannot be done the joint may be resected ; but probably a better limb would be left by drawing the fragments as close together as possible and making the patient wear a support for the rest of his life.

## FRACTURES OF THE LEG.

Both bones may be broken ; or the tibia or the fibula may give way by itself. If the violence is indirect, the tibia generally breaks across at the junction of the lower with the middle third (the weakest part), and the line of separation runs from above downward and forward ; the fibula usually gives way higher up. If direct it depends upon the nature and locality of the injury. In either case compound fracture is very common, owing to the thinness of the covering over a great portion of the tibia ; and all kinds of complications are frequently present. The bone may be comminuted, even when the force is indirect ; the neighboring joints may be involved, though the seat of injury is a long way off, owing to the way in which fissures run obliquely, or even spirally, in the thickness of the bone ; the veins and arteries may be compressed, punctured, or torn completely in two ; the muscles extensively lacerated ; the nerves stretched across sharp-edged fragments ; and the skin, even when it does not give way, stripped up to such an extent from the deep fascia, that it seems to float upon a kind of water-bed, and is in imminent danger of gangrene.

### Fractures of the Tibia and Fibula.

This is the most common form, whether the accident is the result of direct or direct violence. In the former case the fractures may be transverse and on the same level; or they may be comminuted to any degree; in the latter they are usually more or less oblique (especially if there is much twisting of the limb), and the broken ends are sharply pointed. In falls upon the feet, particularly when the force is very considerable, and combined with rotation, as in jumping from a carriage in motion, the bones are frequently broken in more places than one.

The displacement is usually distinct at the first glance, though sometimes, when the fracture is exactly transverse, and through the upper part of the leg, or when the surfaces are much serrated, the broken ends retain their normal position. The causes of the deformity are the continuance of the force after the bones have given way, the weight of the part and the spasmodic contraction of the muscles; the persistence (unless there is impaction) is due entirely to the two last, and especially the muscles. The direction depends upon the obliquity. If it runs from above, downward and forward, the lower end of the upper fragment projects beneath the skin, being driven to the front by the pressure of the other; if it has the opposite direction, the lower of the two is the more prominent. The fibula has very little influence.

**Signs.**—These are usually definite, though a few cases are on record in which a person with both bones broken has been able to stand, and even walk. Crepitus, undue mobility, and deformity are almost invariable; pain is intense, and increased by the slightest pressure; and loss of power is practically complete. The greatest care must be taken in manipulation to prevent the skin giving way; and, for the same reason, the limb must always be made secure at once. It should be a rule to examine the condition of the arteries, particularly the posterior tibial, in all fractures.

**Treatment.**—Fractures of both bones may be divided roughly into three classes.

(*a*) If the limb is so badly crushed that it is doubtful whether it can live, it is better to arrange it as comfortably as possible between sand-bags, or to tie it up on a pillow, so as to make it secure against any incautious movement, and raise it well, in the hope that the circulation may recover.

(*b*) If the fracture is transverse, or nearly so, and if, as usually happens in these cases, the surrounding structures have almost escaped, there is no reason why the limb should not be put up at once in some form of immovable apparatus. This holds good with even greater force when only one bone is broken and the other is left as a splint.

(*c*) If the fracture is very oblique, particularly if it is of that variety which is sometimes called pen-nib, from the way in which the point of one of the fragments projects beneath the skin, or if the bone is extensively comminuted, or the soft parts much injured, and the swelling already serious, it is safer to postpone this for ten days or a fortnight, and to make use of ordinary splints, until the tendency on the part of the muscles to cause displacement has in some measure disappeared, and the swelling and tension are beginning to subside; with such an injury there can be no object in getting the patient out of bed.

The variety of splints that have been devised for fractures of this kind is almost endless. The great object is to secure muscular relaxation; the fragments should fall of themselves into their natural position; force must be avoided as much as possible, though in a few cases continuous extension answers where nothing else will. One of the simplest and most efficient appliances consists of back and two side splints swung from a cradle. The former is made of metal, sufficiently strong to retain its shape, but capable of being bent, and should reach half-way up the thigh to form a sole-piece for the foot. At the heel there is a large perforation to avoid pressure, and two cross-bars to sling it by are soldered to the under surface. It should be fitted accurately into all the curves

of the opposite limb before being padded, and especial care must be take
make the bend correspond with the position of the knee; extra pads to e
special pressure on certain points should be used as little as possible. If the
piece is at right angles to the leg (or with advantage a little less), and if the k
is sufficiently flexed (as much as 60° if necessary) the broken fragments fall i
their natural position of themselves. Division of the tendo-Achillis, though
fectly safe, is very rarely required, and continuous extension is seldom of serv
except in those rare instances in which, owing to the direction of the fracture
spasmodic contraction of the quadriceps, the lower end of the upper fragment
tilted forward. The secret is to keep the knee well bent, the foot at right angl
and the inner side of the great toe, the inner malleolus, and the inner border
the patella in the same line. Strapping may be used to secure the foot, but ba
dages only should be allowed above the seat of injury, and for the sake of ne
ness they are to be starched. The side splints are simply straight pieces of de
well padded, sufficiently long to reach from the condyles of the femur to the fo
and sufficiently broad to project well above the level of the limb. Webbing str
and buckles are used to hold them together, and the whole is suspended by lead
bands from a cradle sufficiently large to allow it to swing freely. No moder
movement of the patient can have any influence upon the fragments; but
should not be allowed to lie upon the injured side, for fear of the upper part
the limb becoming rotated while the lower is held fixed.

Another plan is to lay the limb upon its outer side, on a well-padded wood
splint, with the hip and knee flexed, and the foot kept at a right angle by mea
of a sole-piece. The splint should be hollowed to fit the limb, sufficiently long
reach up to the knee, with a prolongation along the side of the foot, and the so
piece screwed to it at a right angle. Opposite the malleolus there should be
perforation to avoid pressure. The patient is placed upon the injured side; t
fragments manipulated into position, and the limb secured by bandages. Ca
must be taken to keep the heel well down, and the foot at a right angle, for fe
of the ankle becoming rigid. If there is any tendency to lateral projection,
short inside splint may be added with advantage.

In some instances the limb may be suspended from an anterior splint, eith
Hodgen's (Fig. 155) or Nathan Smith's, as already described, the angle and t
point of suspension being altered to fit the case; it is easy to make extension, a
the limb, when it is once adjusted, is exceedingly comfortable, but it is very diffic
to prevent the foot from pointing, and they certainly do not secure the sa
degree of immobility as the others. Probably the majority of the fractures th
admit of being treated in this way might as well be put up at once in one of t
many forms of immovable apparatus.

At the end of ten days or a fortnight, according to the condition of the fra
ture, the splints may be removed and some form of immovable appliance subs
tuted, such as an ordinary plaster-of-Paris or gum and chalk bandage. Care m
be taken first to get rid of all œdema by means of elevation and pressure. T
following plan, for the details of which I am indebted to Mr. E. N. Nason, is
common use at the London Hospital. Equal parts (by weight) of finely powde
prepared chalk and common gum acacia are taken; the latter is made into mu
age, somewhat stronger than the B. P. strength, and is then thoroughly mixed w
the chalk, until the whole is about the consistence of cream; this is strai
through coarse muslin in order to get rid of the lumps. The leg is then thoroug
oiled, and a common cotton stocking, with the point of the toe cut off and la
enough to fit easily, is put on, outside inward, a piece of stout tape being arran
along the front of the leg beneath it. A second stocking, slightly larger than
first, is put on over this, the leg is supported in position, taking care that the f
is at a right angle, and the mixture of gum and chalk is thoroughly rubbed in.
third stocking of the same size as the second one is now drawn over the other t
right side outward, and more of the mixture rubbed in until no more can be
sorbed, and the ribs of the stocking show up clearly. The whole is then suspen

the tape, which lies beneath all the stockings, slung from a cradle and left to y. This takes eighteen hours, unless quickened by placing the patient near the e, or putting hot-water bottles on either side, the limb, of course, being kept tside the bed-clothes. If silicate of potash is used instead of gum, a somewhat tter splint results. The solution (which can be obtained in gallon jars) is mixed ith the chalk in the same way, but not so much chalk is required, and it only kes six hours to dry. When the splint is firm, it is cut down the middle line in ont, along the tape, trimmed up, and the edges bound with strapping to prevent aying. Eyelet holes are then punched on each side, and eyelets put in and lamped with the instruments commonly used by shoemakers. The leg is enveloped in a domett or soft flannel bandage, the splint put on and laced up the front as tightly as may be required. For lightness combined with strength these splints can hardly be surpassed; the fit is perfect, and at the same time they are sufficiently elastic to be taken on and off if required without injury. The plan of suspending the limb by the tape is not only of assistance in dividing the splint, but helps materially to keep the foot at a right angle; unless this position is obtained the splint must be condemned at once.

Many cases of fracture, especially if only one bone is broken, as already men-

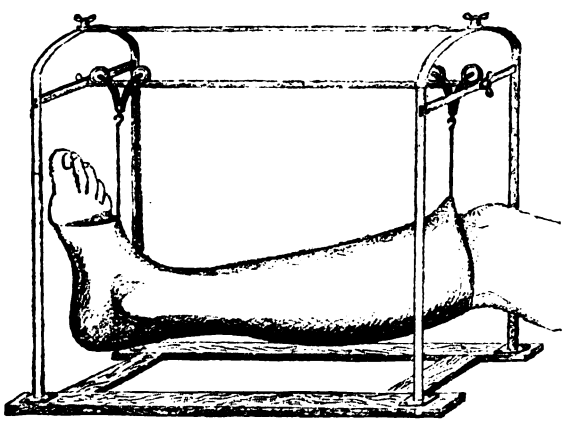


FIG. 168.—Stocking Splint.

tioned, may be put up immediately; but either the splint must be made in two halves or it must be cut down the centre, and laced or fastened up again in some other way, so that in case of swelling the seat of injury is accessible at once. As a matter of precaution the limb should be raised for forty-eight hours after the splint is applied, and the circulation in the toes must be constantly examined. Absence of pain is not by any means incompatible with gangrene.

Poroplastic felt splints (which may be obtained in sizes shaped already to some extent at most instrument makers) answer admirably. They should be fitted roughly to the other leg so as to make sure that the length and breadth are correct, and softened with heated air or water, and then moulded to the fractured limb while it is held in position. They become dry and firm in a few minutes, and then they can be removed, lined with wash-leather, and either fitted with eyelet holes and laces, or fastened on directly with webbing straps and buckles.

Plaster-of-Paris is more extensively used for this purpose, especially since what is called the Bavarian splint became known; before this, bandages of crinoline muslin, into which the dry plaster had been rubbed, were wound round and round the limb until the requisite degree of strength was obtained; and if it was desired to loosen or remove this, it had to be cut, and probably was spoiled. The plaster must be the finest, such as modelers use, and freshly prepared, or, if there is the

least doubt, baked; the setting may be quickened by the addition of a small quantity of alum to the water. Two pieces of coarse house-flannel are taken, long enough to reach from the popliteal space to the balls of the toes and three inches wider than the circumference of the limb; these are sewn together down the middle line for the length of the leg; below this (for the length of the foot) they are cut in two. A very good idea of the shape and size required may be obtained by taking a stocking, cutting the toes off, slitting it down the middle line in front for the whole length, and down the middle line of the sole behind; but the flannel must be three inches wider. The leg is then placed upon the flannel so that the seam runs down the back and ends at the point of the heel; and the inner layers are folded over and fastened together down the front. The end portions are used to cover in the foot, which must be kept exactly at a right angle. The leg is then placed upon one side, and held accurately in position; a layer of plaster the consistence of cream is spread over the inner layer, from the fold in front to the seam behind, and the outer one pressed down upon this before it has set (Fig. 169).

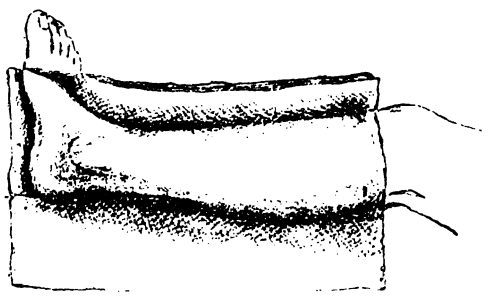


FIG. 169.—Bavarian Splint.

As soon as it is firm the leg is turned over and the process repeated on the other side. Finally, the fastening down the front is undone, and two side splints, fitting accurately to the leg and foot, fall apart from the limb, bending at the hinge formed by the stitching behind. The edges are finished off afterward, the inner layer being fastened down to the outer on the surface of the splint.

Modifications of this, introduced by Croft and Gamgee, are simpler of execution, as the side splints are separate throughout. For the former, four pieces of house-flannel are taken, the size and shape of the patient's stocking when flattened out; two of these (one for each side of the limb) are dipped in warm water, to go next the skin; the two others, the outer ones, are thoroughly soaked in plaster the consistence of cream. A bed is then prepared for the leg, consisting first of a layer of stout muslin cut so as to act after the fashion of a many-tailed bandage; then one of the pieces that have been dipped in plaster, and a second simply wetted. On this the leg is placed, the surgeon making extension and adjusting the fragments as far as possible; then the other pieces are laid upon the upper surface, and the muslin is brought up and fastened over the limb so as to press the layers of flannel against it. In this way two strong plaster moulds are made, one for each side, fitting the leg accurately; and as soon as the plaster sets they can be separated by simply cutting the muslin.

In Gamgee's method the principle is the same, but instead of house-flannel, absorbent cotton-wool is used, one layer next the skin, the other dipped in plaster cream, moulded on the outside of this.

### FRACTURE OF THE TIBIA.

The shaft rarely gives way by itself except as the result of direct violence; the internal malleolus, however, may be wrenched off; the tubercle torn away by sudden contraction of the quadriceps; and the spine, and even the head of the bone, split in two by the tension of the crucial ligaments in violent twists of the knee. As a rule there is no difficulty in the diagnosis; but if the line of separation is exactly transverse, especially in the upper part of the bone, and if there is much ecchymosis, so that it is not possible to feel the edge of the crest, it may be necessary to wait for some days, treating the case as a fracture in the meantime.

ne deformity so long as the fibula is intact cannot be serious, though there is metimes a certain amount of rotation at the lower articulation. Union takes ace readily; but in a few cases, in which the patient, in spite of the pain, has ntinued to use the limb, a false joint has formed, the fibula becoming bowed and rtly strengthened, so as to take more than its share of the weight. In all cases fracture near the upper extremity of the tibia the condition of the knee-joint st be carefully examined, as it is not uncommon for fissures in the bone to run ward as well as downward in the shaft.

### Fracture of the Fibula,

n the other hand, is of very common occurrence. It may be due to direct or ndirect violence; in the former case the situation of the fracture depends upon he locality of the force; in the latter, when the foot is twisted round between the malleoli, it generally takes place at the weakest spot, two to four inches above the ankle-joint; sometimes, however, it is higher up, under cover of the muscles, and occasionally in both places at the same time. In many instances the diagnosis is very difficult; and it is not improbable that fracture is present, without being detected, in a large number of sprains. A slight degree of mobility and crepitus can generally be made out by pressing alternately with the thumbs side by side over the seat of injury, or by forcibly twisting the foot; deformity is exceptional in uncomplicated fractures. In other cases the only sign is the loss of spring when the bones are squeezed together; the fibula yields and gives instead of recoiling; or ecchymosis makes its appearance days after the accident; or there is one spot at a distance from the apparent seat of injury, very tender on pressure; and it is of unusual significance if this spot remains constant when the bones are squeezed together higher up or lower down.

Fractures of the head and neck of the fibula are far from common; but they sometimes occur from direct violence, or from muscular action, the tendon of the biceps and the external ligament combined tearing the upper part off from the rest. In many of these cases the peroneal nerve is injured too.

**Complications.**—*Pott's Fracture.*—Fracture extending into the ankle joint may be caused in various ways. The most common is violent eversion of the foot; the astragalus is twisted round in its socket; the external malleolus is forced outward until the fibula gives way and breaks inward toward the tibia; and the internal lateral ligament is stretched until it either tears across itself, or drags off part of the internal malleolus (Fig. 170). If the force continues after the bone is broken, or if the patient tries to walk, the foot is displaced to such a degree that a kind of dislocation (Pott's fracture) is produced. In very severe cases the interosseous ligament between the tibia and fibula is torn as well, or a portion of the tibia is split off (Fig. 172); in the worst of all the displacement is carried so far that the whole of the foot and the external malleolus are displaced to the outer side of the leg (Dupuytren's fracture).

Forced inversion causes an injury of a similar character; only the strain falls upon the external lateral ligament, and the lower end of the fibula is pulled inward until the bone breaks at its weakest spot (Fig. 171). If the force is not exhausted, the internal malleolus or the lower end of the tibia gives way as well.

In other cases a fissure, starting from an oblique fracture of the tibia, runs down in the substance of the bone until it traverses the ankle joint; or the tibia and fibula are separated from each other and the astragalus driven up between them; or both malleoli are broken off so that the foot can be moved freely in all directions upon the leg. These complications, however, are much more rare. As a rule the diagnosis does not present any difficulty; the character of the displacement and the shape of the swelling (for the synovial sac becomes distended with blood at once) can be recognized immediately; but in every case of fracture of the fibula by indirect violence, if there is the least tenderness on pressure over the internal malleolus, the patient should be warned that the joint is very likely to

be stiff and weak for a considerable time after the accident. Most of these f tures can be put up at once, either in the Bavarian splint or in some modific of it; the foot falls into its natural position as soon as the muscles are rela But every now and then cases are met with in which the deformity obstinately turns, and one or two are recorded in which, in spite of division of the te Achillis, it could not be reduced at all, probably from splintering of the bones inability to disengage the fragments. For such as these, either an outside sp with a foot-piece, as already described, or Dupuytren's (Fig. 173), answers be The latter consists of a straight piece of wood about four inches broad, and ficiently long to reach from below the foot to above the knee. The padding doubled opposite the malleolus and does not extend below it. The splint is f

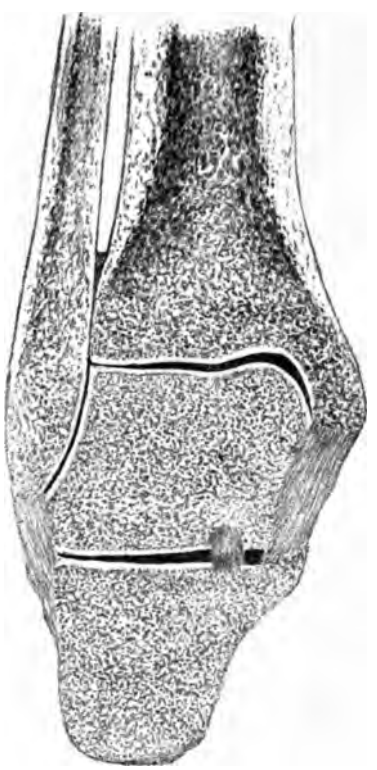


FIG. 170.—Eversion of Foot, forcing Fibula inward, and throwing strain on internal Lateral Ligament.

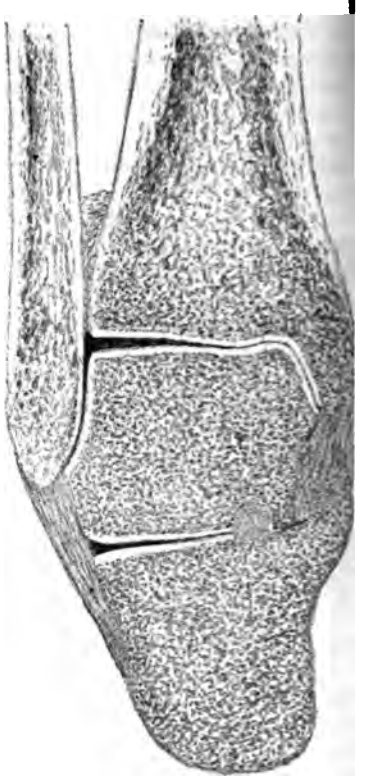


FIG. 171.—Inversion of Foot, forcing Fibula ou ward.

bandaged to the inner side of the leg (the knee being well flexed) and then the foo is drawn over the projecting pad and secured to the lower part by a figure-of-eight no turn of which must be allowed to come above the ankle. A foot-piec corresponding to the sole may be added with advantage.

In all these fractures the greatest care is necessary to prevent any droopi of the toes or carrying backward of the foot; if the distance between t malleoli is altered in the least, whether it is increased or diminished, lamen and serious disability are sure to follow. Passive motion should be commenc in three weeks, and to allow of this it is essential that the apparatus used shou either be laced up or so arranged that it may readily be taken off and o Stiffness, œdema, and a sense of weakness about the joint are very comm after-troubles, and must be met by massage, galvanism, friction, and shampooin

the internal lateral ligament has given way and the weight of the body is owed to fall too soon upon the injured part, an obstinate form of flat-foot may sult.

*Separation of Epiphyses.*—This is more ommon at the ankle than at the knee; in the tter situation it has been produced by forcibly ttempting to straighten a case of genu valgum; nd when the cartilage has been softened by eighboring inflammation partial displacement s not rare. The lower epiphysis of the tibia is sometimes separated in a violent strain of the ankle joint, and, this may be followed by impaired growth. When this occurs, the axis of the bone appears to be altered; the internal malleolus remains small; the fibula becomes much stronger, so as to support some of the weight of the leg, and is bowed outward; and the external malleolus grows so much longer and larger than the other that the sole of the foot is turned inward.

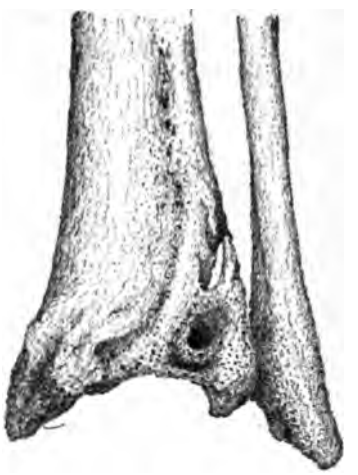


FIG. 172.—Old United Fracture through lower end of Tibia, with separation of the two bones, the Interosseous Ligament having remained intact.

*Wounds of Arteries.*—The anterior and posterior tibial arteries may be injured in simple as well as compound fractures; and the former may be torn as it passes between the bones, even when the seat of injury is some distance off. If the skin is unbroken and the soft parts are not too much crushed, hemorrhage from the anterior tibial can generally be checked by pressure; either the blood is absorbed and the artery closed, or a traumatic aneurysm forms, to be dealt with later on. When the upper part of the posterior is torn this rarely happens; as a rule, the swelling is so great that the collateral circulation is cut off, and the foot soon becomes cold and gangrenous; or it may hang in the balance for a day or two, and then require amputation. In one or two cases, however, in which the foot retained its warmth, ligature of the femoral has been successful, and compression might very reasonably be tried. In compound fractures, either both ends must

FIG. 173.—Dupuytren's Splint.

be tied (and, owing to the extent of the injury and the retraction of the vessels, this operation is very often impossible), or the limb must be amputated. Wound of the posterior tibial at its lower part is an exception; in one instance, in which the ends could not be found, I succeeded in saving the limb by applying pressure at the expense of a small superficial slough.

## COMPOUND FRACTURES OF THE LEG.

Owing to the superficial position of the bones these are very common. Many, fortunately, are slight, the skin being merely punctured from beneath by one of the pointed ends, through carelessness in carrying the patient, or from his attempting to stand. These should be sealed at once and covered with iodoform, the bone, if it is still projecting, being first thoroughly cleansed with corrosive

sublimate or some other antiseptic. Sometimes it is necessary to enlarge the wound a little or cut off a protruding spike.

At the opposite extreme are those injuries caused by direct violence, where the bone is so crushed and the soft tissues so disorganized that it is clearly hopeless to try to save the limb.

Between these two every grade is met with, and the question of treatment must be decided in each case, first by the age and constitution of the patient (especially the condition of his arteries and kidneys), and then by the amount of injury done to the limb and the complications that are present. The arteries must be examined first; if they can be felt pulsating, and if the skin is not stripped up too far, an attempt may generally be made to save the limb. The wound must be explored with the finger, enlarged if need be, and thoroughly washed out with an antiseptic. Loose splinters must be removed, and if the ends of the bone are bared of their periosteum, or so jagged that they cannot fit, they may be resected and sutured together. Then dependent openings must be made for drainage, all oozing stopped, the wound dressed with some absorbent material so that no fluid can collect, and the limb arranged upon an interrupted splint with pads covered with oiled silk.

If no pulse can be felt in the foot below, the line of treatment must be determined by the warmth of the skin and the amount of sensibility it retains. Next to the arteries, the condition of the skin is perhaps the most important; if

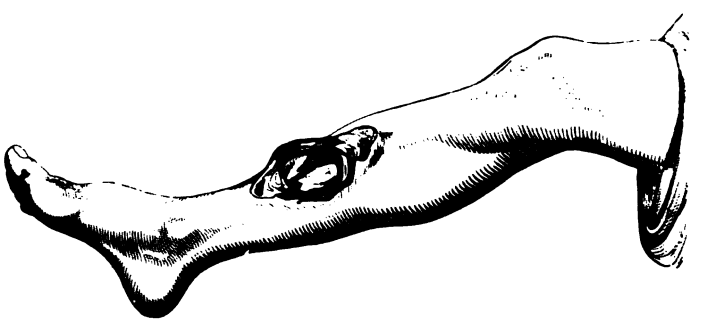


FIG. 174.—Compound and Comminuted Fracture of the Leg.

it is destroyed over a large area, or if it is stripped up so that it is in danger of sloughing, the chance of saving the limb is immensely diminished; and even if this is accomplished it often happens that such an obstinate degree of œdema and ulceration persists that the limb is not only useless, but a constant source of danger and annoyance.

[It is in such cases that the use of hot water made antiseptic shows its higher value. The limb should be enveloped in a sheet wrung out from a hot antiseptic solution, and changed as often as necessary. By enveloping the wet sheet in rubber cloth the heat will be retained for a longer period.]

Everything depends upon the next few days. Sometimes, in spite of every care, the foot becomes colder and colder, the skin more dusky, and the sensibility less. Too much has been tried, and local traumatic gangrene is setting in. The only hope then lies in immediate amputation; the part cannot be kept aseptic; the sloughing is sure to spread, and it will not stop at the seat of injury. If the patient is young and healthy, there is a fair amount of hope still, provided the operation is done at once; if old or broken-down, so that the gangrene is rather the result of impaired vitality than of extensive injury, the prognosis is as bad as it can be.

Sometimes, on the other hand, acute inflammation sets in and rapidly becomes diffuse; the temperature rises, the skin becomes hot and burning, and tense fever, with perhaps delirium, follows. The leg is red, glazed, and immense

ollen; the discharge from the wound is offensive, and soon becomes profuse; e swelling rapidly extends up the thigh, especially on its inner side, and the ighboring lymphatic glands become enlarged. The extravasated blood has de-mposed; the poison is pent up, unable to escape, and may infect every tissue the leg—skin, cellular tissue, periosteum, medulla, lymphatics, and even, per-aps, the veins. The issue depends upon which is the stronger, the irritant or e tissues; if the former, hopeless gangrene sets in and the patient is almost cer-ain to die from acute septicæmia. If the latter, a wall of vascular lymph is grad-ally formed, and the poison shut off. Even then the course is not always straight. Cellulitis, requiring incisions to be made all over the leg, may set in, leaving the imb almost useless; necrosis, sometimes involving a large portion of the bone, is almost invariable; phlebitis and pyæmia may occur at any time; the inflammation may involve the neighboring joints, either by direct extension, or by spreading along the lymphatics into the synovial cavity; and the patient, if he survives the immediate dangers of septicæmia and pyæmia, may sink later on, from exhaustion. Amputation, so long as the fever continues high, is practically hopeless; when the temperature begins to drop of a morning a favorable moment can sometimes be seized; until this occurs, all that can be done is to meet the symptoms as they arise.

### Fractures of the Bones of the Foot.

The posterior extremity of the os calcis is sometimes torn off with the tendo-Achillis by violence; and occasionally the body of the bone is crushed to pieces by falling or jumping down upon the heel. The astragalus may be broken in the same way and at the same time; or the neck may be twisted off in violent wrenches of the foot. Very often the bone is partially displaced. The existence of the fracture can generally be made out without difficulty, but it rarely happens that an exact diagnosis as to its seat and direction is practicable. The fragments should, in all cases, be manipulated as much as possible into position while the patient is under an anæsthetic, and then fixed with a plaster bandage. Passive motion should not be delayed for more than ten days or a fortnight, for fear of permanent stiff-ness of the ankle.

Compound (open) fractures of the bones of the foot are common, but no definite rules can be laid down as to their treatment. In any operation the tread of the sole should be interfered with as little as possible; and it must always be remembered that stability is the first consideration. [The hot antiseptic pack should generally be applied for the first twenty-four hours, preliminary to applying the immovable plaster.]

## SECTION III.—DISEASES OF BONE.

### ATROPHY.

In old age the bones undergo a natural process of wasting, the central canal enlarges and encroaches on the cancellous tissue at either end, the compact portion of the shaft becomes thinner and thinner, until in some cases it is scarcely capable of sustaining the weight of the part, and the medulla is replaced by fat. The same thing may occur from prolonged disuse, as, for example, in cases of old joint-disease (Fig. 175), and must be remembered in the reduction of old dislocations.

FIG. 175.—Atrophy of Bone; vertical section through lower end of femur.

Gradual absorption of bone, as of other tissues, is caused by constant pressure. An aneurysm, for example, may perforate the sternum or eat away the bodies of the vertebræ until the strength of the spinal column is seriously impaired. The blood-vessels are compressed, the bone wastes away, and though the compact layer is to a great extent retained, the cancellous tissue is more or less exposed.

Arrest of growth is not uncommon as a consequence of rickets, hereditary syphilis, and other affections of the growing portion of the bone during childhood. Not only is the length of the bone less than natural, but sometimes, as in the case of the pelvis, there is an arrest of development as well. The same thing may occur from injury.

### HYPERTROPHY.

True hypertrophy may be congenital, the bones becoming involved together with, and in the same proportion as, the other tissues of the part; or it may arise from over-use, as a measure of compensation; the fibula, for example, being immensely strengthened, without undergoing any material change of proportion, in cases of partial or complete loss of the tibia.

Chronic inflammation not unfrequently gives rise to great alterations in size; but in this case the structural details of the bone undergo modification at the same time. In hereditary syphilis, for example, and in osteitis deformans, the bones often increase in length as well as in circumference, but on section the normal proportion of compact and cancellous tissue is not preserved. Increase of length from chronic inflammation, affecting the epiphysial line during the growing period, is still more common.

### INFLAMMATION.

The changes that take place in inflammation of bone are similar to those that occur in inflammation of other tissues; the apparent difference is due to the presence of a solid framework which plays an entirely passive and secondary part.

In compact bone the active vascular tissues lie partly on the exterior (the soft layer of the periosteum), partly in the central canal (the medulla), and to a much

smaller extent in the substance of the bone itself, in the Haversian canals, and the lacunæ. Inflammation may commence in any one of these, as periostitis, osteomyelitis, or osteitis, and although it never remains confined to one, but very soon involves the whole, it is often so much more marked in one than in the other that they may well be described as separate affections.

In cancellous bone, on the other hand, interstitial osteomyelitis or osteitis is practically the only form; there is no central canal, the medulla is distributed evenly through the whole, and although there is a periosteum, the layer of compact tissue which it supports is so thin that, even if an affection begins distinctly in one part, the rest of the bone becomes involved almost at once.

**Pathology.**—The pathological changes are the same as in the other tissues of the body; hyperæmia, dilatation of the blood-vessels, and increased rapidity of the flow, followed at a later period by stasis, if the attack is sufficiently acute. Lymph pours out through the walls of the vessels, the tissues become engorged and swollen (so far as they can, for therein lies the difference), the matrix becomes softened (if there is time), new blood-vessels are formed, the amount of exudation continues to increase, and at length periosteum and medulla are replaced by layers of soft, exceedingly vascular lymph or granulation-tissue, as deep and as thick as space will allow.

The subsequent course depends upon whether the inflammation is acute or chronic, and whether the portion of bone involved is compact or cancellous.

### 1. Acute Inflammation.

When connective tissue is inflamed, the intercellular substance rapidly becomes softened (unless it is a sheet of very dense fascia), the vessels can expand and enlarge in all directions, and there is scarcely any limit to the amount of lymph that can be poured out. This is not the case in bone, especially when it is compact. It is true that as soon as inflammation commences the osseous framework begins to change in a similar way; it gradually becomes softened and eroded on its surface (whether under the periosteum, round the medulla, or in the Haversian canals), and special multinuclear cells to which this function is assigned (osteoclasts) are found in all these places, lying in little recesses (Howship's lacunæ) which they have eaten out for themselves; but, while fibrous tissue can soften and yield at once, it takes time in the case of bone, and consequently, if the attack is acute, either stasis occurs, without the possibility of any collateral circulation, or the blood-vessels become strangled in their own canals by the exudation around them. In other words, as in carbuncle at the back of the neck, if inflammation is acute, the circulation is stopped, the tissues perish, and gangrene (necrosis) occurs.

In compact bone this is the rule. Acute inflammation, if it is not followed by immediate resolution, ends in necrosis. If the periosteal surface is involved (*acute periostitis*), the sequestrum, as it is called, is superficial; if the medulla (*acute osteomyelitis*), it is central and tubular in shape, formed from the layers that immediately line the canal; if both together, the whole shaft perishes (*total necrosis*).

In cancellous bone, where the spaces are larger and wider, necrosis is more rare; the vessels have more room, dilatation and exudation are possible, and there is less solid bone to be absorbed; but if the inflammation is so intense as to cause thrombosis or stasis over any extent, the result is the same, and as a matter of fact small rounded sequestra of cancellous bone are not uncommon in the centre of suppurating foci.

When a sequestrum is formed, the dead portion acts as a constant irritant until it is separated and thrown off by a process of rarefying osteitis; so that an acute attack of inflammation causing necrosis must be followed by a chronic one.

### 2. Chronic Inflammation—Rarefying Osteitis.

When the exciting cause is not an acute one the bony trabeculæ have t to soften; the amount of exudation increases, more vessels are formed, the sp enlarge, the solid walls that surrounded them are removed little by little, and t affected portion of bone becomes open and porous. Compact tissue beco cancellous, cancellous tissue so soft that it can be cut with a knife.

If this commences on the outside the periosteum becomes softer, thicker, a more vascular, the tough fibrous layer is lifted up from the bone beneath by ma of newly-formed lymph (forming, if the bone lies immediately under the sk what is commonly called a *node*); and if it is torn off, it leaves a surface that not white and smooth, but rough, uneven, covered with little bony spicules, a dotted all over with minute openings (Fig. 176). If the medulla is involved firs the changes are essentially the same; the old spaces are enlarged, new ones ar formed by the disappearance of the partitions, and the medullary canal is filled with soft masses of vascular granulation-tissue.

The simplest type of chronic inflammation is seen in the process by which a necrosed portion is separated from the rest. The living bone all around becomes more vascular, the Haversian canals expand and become filled with lymph, the solid matrix next to the sequestrum is absorbed and replaced by granulation-tissue, and by degrees a line of demarcation cuts it out. The necrosed part is detached by the irritation it causes, at the expense of the living bone around it, and lies in a cavity, the walls of which are formed everywhere of granulation-tissue, springing from rarefied bone. In the majority of instances suppuration occurs, but it is not an essential part of the process.

Fig. 176.—Chronic Inflammation of Bone. The Tibia and Fibula from an old amputation, showing excessive vascularity with great production of new bone.

The subsequent changes depend partly upon the intensity and persistence of the cause, partly upon the strength of constitution of the patient.

(*a*) *Resolution.*—When the irritant is but slight and transient, resolution soon begins: the vascularity diminishes, some of the lymph becomes absorbed, the rest is organized, and in a short time the natural condition of the part is perfectly restored. The changes that take place after a simple fracture are a very good illustration.

(*b*) *Persistence* (*Caries sicca or fungosa*).—In other cases the process continues without altering in character until the whole of the bony framework is absorbed; nothing but a mass of soft granulation-tissue is left. The whole body of a vertebra may be removed in this way so as to cause angular curvature of the spine, and the phalanges of a finger may simply disappear until the nail rests upon the head of the metacarpal. Extreme forms of this kind appear usually to be associated with tubercle, but there is no caseation. Dead bone may be absorbed as well as living; a sequestrum, so long as it is surrounded by living granulation-tissue (not by pus), gradually diminishes in size, being eroded and eaten into from the surface in the same way as an ivory peg.

(*c*) *Organization* (*Osteosclerosis*).—In some diseases, rheumatism for example and not unfrequently syphilis, the vascular granulation-tissue becomes organized and converted into bone. This is especially prone to happen at a little distance from a focus of suppuration, and not uncommonly extends all round and encloses it (Fig. 178). When it occurs in the substance of a bone, the trabeculæ, instead of softening and disappearing, become hardened and thickened; the cells that lie upon their surface are incorporated with them; the spaces left between filled with soft granulation-tissue, become smaller and smaller; the Haversian canals are narrowed; and at length the affected portion of the bone is converted into a dense

hard, and heavy mass, like ivory. If the medulla is involved, the canal simply disappears; it is completely filled in; if the periosteum, the changes are essentially the same; layer after layer of lymph is thrown out upon the surface and converted into bone, until the natural exterior of the shaft is coated over with a ring of newly-formed osseous tissue, and the thickness of the wall is doubled or trebled (Fig. 179). The so-called expansion of bone over central sequestra or sarcomata is produced in a similar way: as the interior becomes hollowed out and weakened, the periosteum on the outside maintains the strength of the part by the new bone it forms, until perhaps the whole of the original shaft disappears, and a new shell with a much larger cavity is developed in its place (Fig. 188).

FIG. 177.—Suppurative Periostitis and Osteomyelitis of Tibia; the sequestrum, which is locked in, involved the whole thickness of the bone. Owing to the constant irritation near the epiphysial line the upper end of the tibia has grown obliquely.

For the most part this change is to be regarded as reparative in character, but sometimes it leads to consequences which, instead of being beneficial, make matters worse. One has been mentioned already: a suppurative focus in the cancellous end of a long bone may be completely locked in; layer after layer of dense osseous tissue is formed around it until escape is impossible; but unhappily, this process is rarely uniform; the periosteal surface becomes thickened (Fig. 178), but not the articular, so that if a joint is near and suppuration continues, the pus is almost certain to work its way into the cavity and lead to destructive arthritis.

In other cases the Haversian spaces and the medullary canal become so constricted that the amount of blood going to the part is scarcely sufficient to maintain its life, and the least irritant causes necrosis. Sometimes apparently none is required. Paget has described a form of *quiet necrosis* in which there is no suppuration, or exceedingly little; the sclerosis simply continues until the vascular canals are obliterated and the central portion of the affected area dies. The sequestrum formed in this way may take years before it is completely detached. Meanwhile it acts as a continual irritant, the bone around is kept in a state of chronic inflammation, and either rarefying osteitis sets in, and the strength of the part is so much impaired that spontaneous fracture takes place, or it becomes denser and harder, and layer after layer of new bone is laid down, until at length the circumference is doubled. In either case, the diagnosis from malignant disease is exceedingly difficult, and not infrequently the actual condition has only been recognized after amputation.

Syphilitic inflammation of bone, especially the inherited form that occurs at puberty, is often followed by an extreme degree of sclerosis. The whole of the shaft, generally of the tibia, becomes enlarged and condensed; superficial sequestra form, probably from gummatous infiltration of the periosteum; and owing to the extreme density of the bone beneath, it may be years before they are loose enough to be removed. The same thing is not uncommon after acute necrosis of the lower end of the femur; the sequestrum, especially when the posterior surface is involved, may remain adherent for the rest of life.

Closely allied to this are the changes in shape and size, as well as in density,

which are sometimes met with in adults. In most instances (osteitis deformans, for example) they are the result of some general disorder of nutrition, and the whole skeleton is affected more or less; but occasionally alterations of a similar description—elongation, curving, irregularity of the surface, disappearance of the medullary canal, and condensation—are produced by purely local irritants.

In children, before the epiphyses have united, the growth of the bone in length, as well as the shape, may be very seriously affected by premature condensation. Ossification sets in, the epiphysis is joined to the shaft before full size is reached, and development is stopped. In other cases, exactly the opposite result follows; owing to the greatly increased vascularity of the part unnatural growth takes place and the bone becomes very much elongated. This may occur on one side of the bone only, so that the axis of the limb is seriously distorted (Fig. 177); or in one of a pair and not in the other, in the tibia, for example, and not in the fibula, so that the neighboring joint is rendered almost useless.

### 3. Caries.

Of this there are two varieties: (*a*) simple or non-specific, in which pyogenic organisms only are present; and (*b*) specific, in which the destruction is due to tubercular, syphilitic, or leprosy germs, with or without the others. In the first variety the granulation-tissue breaks down into pus directly; in the second fatty degeneration and caseation set in first, and suppuration is a complication. In both the trabeculæ that are not absorbed are deprived of their nutrition and perish; and small fragments of dead bone drop off into the fluid that surrounds them. When the inflammation is acute, the sequestra may be of some size (*caries necrotica*); ordinarily they are very minute.

Caries may occur either on the surface of compact bone or in cancellous tissue. The former is most often met with in connection with syphilis. A gummatous deposit forms in or under the periosteum, softens and breaks down, leaving a foul-looking ulcer, the floor of which is formed of roughened bone, soft, and, as pyogenic germs are always present in sloughing gummata, covered over with pus. Underneath, if this is scraped away, there is a border of rarefying osteitis; and as a rule, further off, one of sclerosis, the difference depending upon the diminishing intensity of the irritant.

In cancellous tissue it is much more common. The carpus and tarsus, the bodies of the vertebræ and the articular ends of the long bones, are the favorite places. It begins as rarefying osteitis; the Haversian canals become dilated; the trabeculæ are absorbed, all the spaces enlarge, and very soon the affected part is converted into granulation-tissue with only a few bony spicules left. If the cause is a transient one, resolution or organization follows, and the damage is repaired. If, on the other hand, living organisms are present, and they continue to grow, the newly-formed lymph is killed, the solid tissues break down and become liquid, the trabeculæ that are not absorbed die and drop off as a minute sequestra; and in a little while a cavity is formed, filled with fluid debris, and surrounded by a wall of softened, congested bone.

(*a*) *Simple Caries.*—In a chronic abscess of the cancellous end of one of the long bones, such as is sometimes caused by injury (Fig. 178), all these changes may be found existing together, side by side. In the centre is a sequestrum; thrombosis occurred in some of the vessels at the time of the accident, the collateral circulation could not be established, and necrosis resulted. Around this is a cavity filled with pus, a few (but only a few) germs having reached it through the blood. The bone which originally occupied this space has been absorbed; the inflammation was not sufficiently severe to kill the part *en masse* as it did in the centre; there was time for rarefying osteitis to set in; the bony trabeculæ were removed; the granulation-tissue that replaced them melted away into pus, and an abscess-cavity resulted.

The wall of the abscess is lined with a so-called pyogenic membrane—in

er words, vascular lymph or granulation-tissue, which has caused the removal every particle of bone, and has been able to resist the action of the pyogenic anisms. Around this is a circle of rarefying osteitis, gradually becoming less d less characteristic as the distance in- ases. Close to the cavity there is only a ny spicule left here and there; it is nearly soft tissue, continuous with that lining e abscess and furnishing by its death the s that fills it. Further away the proportion reversed; and at length, quite on the out- de, where the effect of the irritant is scarcely lt, organization has taken place, the bone is rd and dense (sclerosed), and new layers re thrown out under the periosteum.

These changes are the result of two rces: one is the destructive action of the ritant, aided by the pyogenic organisms; he other is the effort of the tissues to repair nd limit the damage. The same may be een when caries affects the surface of a one, provided the patient is otherwise ealthy; in the centre, where the irritant is ost active, the destruction is complete; round the margins of the ulcer (for such it really is) and deep down under its floor there is a deposit of new and dense bone.

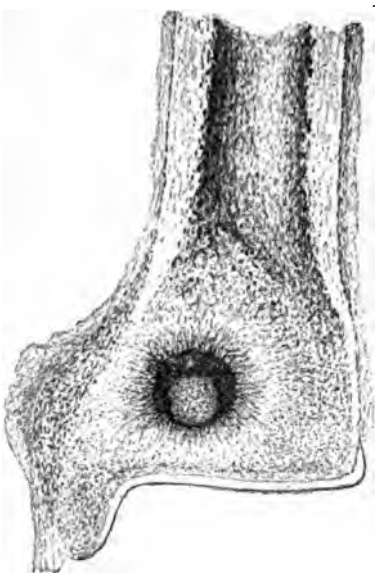


FIG. 178.—Diagrammatic representation of an Abscess in the Cancellous End of the Tibia, showing a central sequestrum lying in an abscess-cavity with vascular bone around, and further away sclerosis and a deposit of new bone.

(*a*) *Specific Caries.*—This is nearly always due either to tubercle or syphilis; the other infective organisms are more rare, and the effects they produce not characteristic.

Tubercular caries is especially distinctive. It is marked out at once from all the rest by the entire absence of repair. So long as the tubercle is spreading, the inflammation is never confined, either by sclerosis or a deposit of new bone. The whole structure is light and porous; there is no evidence of organization, no thickening under the periosteum or sclerosis in the cancellous spaces. The centre is filled with caseous debris or a thin oily fluid mixed with minute sequestra; around this is a layer of granulation-tissue studded with miliary tubercles, which constantly spread wider and wider, while they decay and caseate in the centre. If the nutrition of the bone improves, or that of the bacilli deteriorates, so that the former gains the upper hand and the inflammation ceases to be tubercular, encapsulation and sclerosis occur, as when the cause was traumatic. If, on the other hand, the bone-corpuscles are badly nourished or in a state of fatty degeneration (which is said to be common in tuberculous subjects) there is nothing to oppose the spread of the disease, and it continues until the whole is reduced to a periosteal shell, filled with caseous debris. There is no suppuration unless the pyogenic germs enter as well as the tubercle bacilli, and in sufficient number; if once they do, the destruction becomes infinitely more rapid.

Syphilitic caries presents no special features. It may occur by itself and cause the most extensive destruction (Fig. 185), but suppuration is usually associated with it.

**Causes.**—Inflammation may be caused either by organized or unorganized irritants: the latter may be mechanical (tension or the presence of a foreign body), or chemical (mercury or phosphorus); the mode of action of the former is uncertain and perhaps not always the same.

1. *Mechanical Injury.*—In wounds and fractures the bones, like other tissues, become inflamed if the parts are not kept at rest, if there is any tension or if there

is a foreign body present, such as a sequestrum, and sclerosis or rarefying os sets in, but not suppuration.

2. *Chemical Poisons.*—Some of these, like mercury and phosphorus, are troduced directly from the exterior. Others, as in the case of gout and rhe tism, are in all probability the product of some perversion of nutrition. Wh certain other affections of bone, which are not so distinctly inflammatory in character (such as osteitis deformans, rickets, and osteomalacia) are also d chemical changes in the blood, is perhaps open to argument; but at least no line can be drawn between them.

3. *Infectious Organisms.*—(*a*) *Non-specific.* — Inflammation of the intense character may occur after amputations or compound fractures, especial the medullary canal has been laid open; or by infection from the blood (a suppurative periostitis, osteomyelitis, and epiphysitis), the germ entering e through some cutaneous boil, or, if the skin is unbroken, through the alimen or respiratory tracts, and finding a suitable nidus for its development in the bo It is not uncommon after the acute exanthemata, especially typhoid fever.

As in all forms of inflammation of bone in which necrosis or suppurati occurs, the attack does not cease when the primary cause has spent its energy; sequestrum remains behind as a foreign body and acts as a constant irritant, ke ing up chronic inflammation, until it is detached and the loss repaired.

(*b*) *Specific.*—Periostitis and interstitial osteomyelitis are exceedingly comm in syphilis, both in the acquired and the hereditary form. The inflammation m be acute, occurring early in the course of the disease, affecting the periostea chiefly and ending for the most part in resolution, or chronic, involving the bon as well, and often complicated by suppuration. Sclerosis and hyperostosis a more common in the hereditary form. Tubercle usually affects young subject and nearly always cancellous bones, though it may occur upon the cranium. Othe specific organisms, such as those of leprosy and actinomycosis, are too rare to re quire special mention.

Secondary inflammation of bone, due to extension from structures near, is fre quently met with. Ulceration of the skin, for instance, may extend into the sub stance of an underlying bone and lead to caries; or, in a poisoned wound of th finger, the inflammation may spread along the lymphatics to the tendon-sheath an the periosteum, and lead to acute suppurative periostitis.

## Varieties of Inflammation.

### *Simple Traumatic.*

Contusions occasionally give rise to an effusion of blood under the periosteu or in the cancellous tissue; but except in children it is rarely extensive. The sub periosteal extravasation on the parietal bone in infants after difficult labor (*cephæ hæmatoma*) is an exception. This may attain a very considerable size, though it always strictly limited by the sutures, and may last for months before it is com pletely absorbed, the edges becoming hard and organized while the centre remai soft and semi-fluid. In cases of fracture the extravasation is more extensive, fil ing up the medullary canal and spreading into all the tissues around as well.

The subsequent changes are the same as in other tissues: the blood coagulate the liquid portion disappears, the vessels dilate, lymph pours out through the walls into the remainder of the clot, and all the tissues around become soften and swollen. In other words, the tension and the extravasated blood have caus a very slight degree of inflammation.

(*a*) In the vast majority this is followed by *resolution;* the broken-down cl is gradually removed, the exudation is absorbed, the blood-vessels shrink to the normal diameter, and the structure of the part is completely restored.

(*b*) Occasionally *organization* takes place, and the lymph becomes converte into bone. This is always due to some slight but persistent irritant; it may be

al one, as when organization occurs round the margin of a cephalhæmatoma; re frequently it is constitutional, as in syphilis or rheumatoid arthritis. In these ases the general nutrition is so perverted that if the tissues become inflamed, matter what the exciting cause may be, the attack is not allowed to subside; it aintained and made chronic by the constitutional complaint.

(*c*) In rare instances the death of the part of the bone that is injured takes ace; thrombosis occurs, and if the collateral circulation fails necrosis results. the soft tissues the dead part is removed by fatty degeneration. In bone what known as *quiet necrosis* follows. A portion of the shaft perishes, acts as a foreign dy keeping up a slight amount of irritation, and leads to the formation of dense d thick layers of new bone around, so that sometimes an enormous degree of largement is produced. Suppuration is a complication and not an essential ature; but generally the pyogenic organisms gain access to the injured tissue rough the blood-stream, and a certain amount of pus is formed. If this occurs the shaft of a long bone it is known as chronic osteomyelitis (Fig. 179); if in e cancellous end, as chronic abscess of bone (Fig. 178). Probably in these inances the tissues outside the immediate seat of injury are well nourished, the pyogenic irritants are few in number and capable of but little mischief, and sclerosis oon shuts them in.

**Symptoms.**—(*a*) *Simple acute inflammation* (*traumatic node*). The symptoms are rarely severe. If the bone is superficial the skin is a little raised, perhaps warmer than it ought to be, and adherent to the periosteum beneath; usually it is rather whiter than natural, owing to the way in which it is stretched; only when the inflammation reaches it does it become much reddened. It is always very tender on pressure; if there is any muscle attached to the injured spot the patient will not use it; and there is a constant dull aching pain which grows worse at night as the limb becomes warm in bed, and gradually subsides toward morning. In children there may be slight feverishness, but never such, in simple traumatic inflammation, as to excite anxiety.

(*b*) *Chronic inflammation; chronic osteitis, periostitis, or osteomyelitis; chronic abscess of bone.* The symptoms of all of these are of the same character, though they differ very much in intensity. The most striking is the constant, dull, aching pain, worse at night when the patient gets warm, and worse in wet weather or after exercise. In subacute attacks, or when there is an abscess shut in, it may be very severe. The whole bone is enlarged by expansion and the formation of new layers on the surface, though this often appears to be greater than it really is, owing to the condensation of the soft tissues over it. In periostitis the swelling usually involves only one side, and is irregular and nodular on the surface; when the cause is more deeply seated the outline is generally smooth and even. The skin rarely shows any change, though it may pit slightly on firm pressure if the bone, like the tibia, is subcutaneous. As a rule, there is tenderness over the whole bone, but not unfrequently, especially in chronic abscess of the cancellous end, one spot is exquisitely sensitive; and occasionally it is a little reddened and puffy upon the surface. There is no local rise of temperature, unless the inflammation is nearing the skin, and as a rule little or no constitutional disturbance; but the muscles are not unfrequently wasted, and if the articular end of the bone is involved, the neighboring joint always shows signs of synovitis.

**Treatment.**—Simple acute inflammation, as a rule, subsides rapidly if the part is kept at rest and the amount of blood flowing through it checked by elevation, cold, and lead lotion. Whether necrosis takes place or not depends upon the extent of the thrombosis and the amount of bone which has been deprived of its blood-supply. If, for example, stasis occurs in the diploë of the cranium, the whole thickness of the bone may perish, and there is great danger (if suppuration sets in) of the inflammation spreading to the meninges or the sinuses and causing pyæmia, as, for instance, in Pott's puffy tumor; if only the surface is affected, either there is no necrosis at all, the collateral supply maintaining the nutrition, or the sequestrum is superficial.

If the inflammation, instead of subsiding, persists and becomes chronic, the treatment must be guided by the cause. Sometimes nothing but osteosclerosis can be found to explain it; the inflammatory exudation, under the influence of a rheumatic or a syphilitic constitution, has undergone organization; the whole bone has become hard and dense, and the seat of a chronic, wearing pain. Sometimes, on the other hand, a sequestrum or a minute quantity of pus is locked up either by the compact tissue of the bone itself or by layers of new bone thrown out under the periosteum, or by both together.

In the former case, when the cause is purely constitutional, iodide of potash and counter-irritants (iodine applied locally, blisters, and even the actual cautery) are the chief remedies, special attention being paid to the diathesis that is present.

In the latter, when the pain and swelling are confined to one part of a bone, or when, though the whole is involved more or less, one spot is distinctly more tender than the rest, more active measures are possible. Iodide of potash should be tried first, and may give relief for a time, but if the symptoms persistently return, particularly if one spot in the skin is slightly puffy or œdematous, or if the neighboring joint is liable to attacks of synovitis, the patient should be placed under an anæsthetic, Esmarch's bandage applied, and a free incision made down to the bone, through the periosteum, at the spot where the tenderness is greatest.

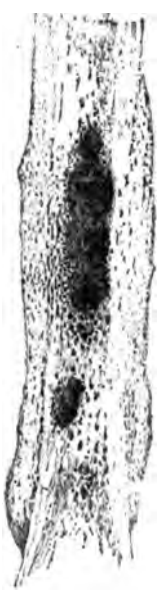


FIG. 179.—Chronic Abscess in the Centre of Shaft of Humerus (chronic suppurative osteomyelitis) leading to sclerosis and the deposit of new bone under the periosteum. The line of the old shaft can still be traced.

If the part involved is the cancellous end of one of the long bones, a trephine should be applied and a circle of bone removed, until the soft cancellous tissue is exposed. If there is an abscess, free exit should be given to the pus, and the cavity should be thoroughly wiped out with an antiseptic, or if there is a suspicion that is tubercular, stuffed with iodoform. If nothing is found, the surrounding bone may be explored by means of a drill. Sometimes the amount of pus is so small that its escape, mixed with bone-debris, is unnoticed. If, on the other hand, the shaft is the part concerned, the operation is essentially the same, but, instead of trephining, linear osteotomy is performed with a Hey's saw, the cut being carried down until the medullary canal is exposed. Even when nothing is found to account for the symptoms, they not unfrequently subside and disappear completely after the operation, possibly from the relief of the tension, possibly from the rarefaction and softening of the compact tissue that follows.

### PHOSPHORUS NECROSIS.

Inflammation of the jaws, of a peculiarly progressive and obstinate character, is not uncommon among those exposed to phosphorus fumes. So long as the teeth are absolutely sound they appear to enjoy immunity, but as soon as they become carious from any cause, inflammation sets in and rapidly spreads to the periosteum, the medulla, and the substance of the bone itself. The spongy part of the alveolar margin becomes exposed, the outer layers of the bone are eaten away, the surface is roughened, the medullary spaces filled with pus in which there is a number of minute sequestra, and the medulla itself is completely destroyed. Sometimes the disease remains limited to the alveolar margin; more frequently the sequestra refuse to separate, and it extends until the whole of the bone has perished and is detached from the periosteum. In the case of the lower jaw there is nearly always a deposit of new bone at the angle, where the severity of the inflammation is less acute; but it is of a peculiarly soft and spongy character, and adheres to the dead bone beneath, so that when the sequestrum is removed it nearly always comes away with it.

The symptoms may be of great severity. The gums become swollen; the [illegible] is very intense; there is a profuse discharge of pus into the mouth, and [illegible]y from this constantly finding its way down into the lungs and the stomach, [illegible]tly from the inability to take a proper supply of nourishment, the health soon [illegible]ins to fail, the inflammation extends to the other parts of the face, and the [illegible]ient becomes utterly worn out.

Very little can be done in the way of treatment until the sequestra become [illegible]se. Dead projecting fragments may be removed from time to time; the mouth [illegible]st be kept sweet by constantly washing it out with Condy's fluid or some other [illegible]tiseptic; abscesses may have to be opened, and the strength must be maintained [illegible] far as possible. In some cases the whole of the lower jaw, with the exception [illegible] the condyles and the attachment of the temporal muscle, can be removed. [illegible]eproduction usually takes place abundantly, and a massive bar of bone is devel-[illegible]ped in its place; but not unfrequently this atrophies again, and nothing but a [illegible]rous band is left to support the mucous membrane. It has been recommended, [illegible]here possible, not to remove the teeth, in the hope that, if their attachment to [illegible]e mucous membrane could be preserved, they might retain a certain degree of vitality and become sufficiently firm again to prove of use.

FIG. 180.—Phosphorus Necrosis, most marked at the alveolar border, with a deposit of new and adherent bone at the angle.

### MERCURIAL NECROSIS.

Exposure to the fumes of mercury (as in a long since abandoned method of silvering glass), or its administration in excess, may cause necrosis either of the subcutaneous bones (the skull, sternum, tibia, or bones of the nose, for example), or of the jaws. In the latter case the origin is evidently local; the mucous membrane first becomes affected, especially around carious roots or where there is an accumulation of tartar; then the periosteum and the lining membrane of the alveoli; the teeth become loose and drop out; and finally the bone itself becomes involved. At the present day it is, fortunately, very rare.

### ACUTE SUPPURATIVE OSTEITIS.

#### *Acute Necrosis.*

This may begin either in the medulla or the periosteum (*acute suppurative osteomyelitis* or *periostitis*); it is always the result of infection; it is much more common in children (especially in boys) than in adults, owing, in all probability, to the greater vascularity and more rapid nutritive changes in the bones during early life; suppuration sets in almost at once, and it is attended with the most intense fever, so that it may prove fatal within three or four days, with all the symptoms of general blood-poisoning.

A closely similar form occurs in infants, attacking the growing layer at epiphyses (*acute epiphysitis*) and leading to suppurative arthritis; and occasio after amputation, in which the medullary canal has been opened, an intense of osteomyelitis occurs from direct infection.

Acute necrosis is most often met with between the ages of eight and eigh and it nearly always affects the long bones, sometimes beginning in the middl the shaft, but more often in the neighborhood of the epiphyses. It may occu perfectly healthy children, but fatigue and exhaustion are certainly predispo causes. One of the most acute cases I have ever seen developed suddenly in course of a chronic attack without its being possible to assign a reason. It nothing to do with scrofula.

**Causes.**—There is usually a history of a blow or of some slight injury a or two before; but although this may determine the locality of the outbreak, perhaps (when the bone is superficial and the inflammation begins in the peri teum) assist the development of the poison by the extravasation it causes, it can be held responsible for more. The immediate agent is undoubtedly an infec germ which enters the blood, either from some cutaneous boil or through the mentary or respiratory tracts, and which finds a suitable soil in the injured It is well known that in pyæmia abscesses are prone to develop at the seat of juries, and that suppuration sets in around simple fractures if animals are fed upo putrid food; and it is possible a similar explanation will hold good for this; th germs are often present, but cannot develop without a suitable nidus having bee prepared.

No specific organisms have been found in connection with the disease; the staphylococcus pyogenes aureus, which is met with in all forms of acute suppura tion, occurs abundantly, so also does the staphylococcus pyogenes albus; sometimes there is a streptococcus too; and not seldom, especially in the worst cases, they are all found together, but they are in no way peculiar to it. In several instances acute necrosis appears to have been secondary to infection from boils; and it has been shown that the pus from a case of this kind rubbed into the skin of the fore arm is capable of producing pustules and furuncles in abundance.

**Morbid Appearances.**—In acute osteomyelitis the changes are practically confined to the medulla; outside, the periosteum is thickened and softened; the fibrous layer, especially near the epiphysis, is separated by a purulent exudation from the bare, smooth bone beneath, and the tissues around are swollen and infil trated with lymph; but often before there is time for anything further the case proves fatal, with symptoms of the most intense blood poisoning. The medull itself disappears; the central canal is filled with purple extravasations and streak of yellow pus; and in the worst cases, if the disease has lasted more than a fe days, even the cancellous tissue at the ends of the bones is loaded with blood-staine pus, on the top of which is floating a scum of oily drops.

In acute suppurative periostitis this order is reversed; and if the tough, fibro layer gives way in time, so that the pus is not retained under such high tensio the morbid process spreads to the tissues around and causes more conspicuo changes. It usually commences on the shaft, in the neighborhood of one of th epiphyses, especially on the posterior surface of the lower end of the femur. Po sibly this is due to the extensive attachment of the gastrocnemius to the periosteum a sudden contraction might tear it from the bone. The tibia, however, suffe almost as frequently; the bones of the upper extremity less often. Pus forms almo at once; nearly always it is mixed with blood, and very often there are oil globul floating in it, coming from the medulla beneath. If it begins on the middle the shaft, the whole of the periosteum may be stripped up within a few hours; if is near one of the epiphyses it extends rapidly to the growing line, and then, bein checked at this point by the much firmer attachment of the fibrous layer, turn inward between the shaft and the epiphysis and spreads into the cancellous tissu This peculiar limitation to the shaft is one of the most characteristic features of th

How far the bone itself takes an active share in the inflammatory process is an open question. Certainly, if the disease continues unchecked, the superficial layers are killed; and if it extends into the medulla the whole thickness perishes; but if free exit is given to the pus at once, even though the bone underneath is bare and white, recovery without any perceptible loss of tissue is not uncommon.

Left to itself, the further progress is simply a question of destruction. The fibrous layer of the periosteum gives way; sometimes the tension to which it is subjected is so great that the whole of it sloughs. The pus, as soon as it gains the soft loose tissue outside, spreads in all directions, and forms huge diffuse abscesses between the muscles. The epiphyses become detached from the shaft; if this occurs at both ends the whole length perishes (total necrosis). The neighboring joints become involved; synovitis always occurs from the mere presence of such intense inflammation near; not unfrequently acute suppurative arthritis follows; either the inflammation spreads along the fibrous layer until it reaches the reflexion of the synovial membrane, or, as more commonly happens, the pus spreads in the soft medullary tissue of the epiphysis until it reaches the articular lamella underlying the cartilage of the joint; this gives way; a small round opening like a minute trephine-hole is formed, and the synovial cavity becomes filled at once with intensely infected septic pus. Other tissues do not fare any better; diffuse cellulitis spreads up and down the limb; the skin becomes undermined; abscesses form and point, perhaps a long way off, and at last symptoms of general pyæmia make their appearance. There is everything to favor such a termination—intensely infective pus, high tension, and inflammation of bone. Sometimes numerous metastatic abscesses form in all parts of the body, especially in the wall of the heart, causing purulent pericarditis; sometimes the constitutional infection is so severe that the result is fatal even before these have time to develop.

FIG. 181.—Acute Suppurative Periostitis and Osteomyelitis (Acute Necrosis) of Shaft of Tibia from a Child. The sequestrum has been removed, and the new shell, deficient in many parts where the periosteum sloughed (cloacæ), is left. The epiphyses are intact.

**Repair.**—If the case does not prove fatal from acute blood poisoning within the first few days, the process of repair commences; the inflammation ceases to spread; the suppuration becomes limited; the tissues that have been killed are gradually detached, and organization begins.

(*a*) In the most intense form, when the periosteum and medulla are both involved, the whole shaft perishes, and the destruction is too great for effective restoration. Fortunately, it usually falls short of this; the growing layer is left; new bone is thrown out; the sequestrum is gradually separated, and even if the shaft is destroyed from end to end and taken away, it is very fairly reproduced.

(*b*) Repair is most easy in periostitis. As soon as the tension is relieved, and the inflammation ceases to spread, the living bone beneath the sequestrum becomes more vascular; rarefying osteitis sets in; a layer of granulations is formed; and gradually the necrosed fragment is entirely detached. Further away, where the effect of the irritant is not felt so much, the lymph be-

comes organized and new bone is formed (osteosclerosis). Similar changes take place on the side of the periosteum, only they have the effect of locking the sequestrum in, so that it can only be released by operation. The under surface facing the dead bone is converted into vascular granulation tissue; in this organization soon begins and a sheath of new bone is formed, covering in the sequestrum, and continuous above and below with that which is still living. At first, like all new bone, it is soft and porous, traversed by numberless little vessels running in from the surface, just as in callus (Fig. 181); but by degrees, if the sequestrum is removed, it becomes harder and denser; and in proportion as this occurs the amount diminishes, until at length the gap in the old bone is filled with tissue which in size, shape, and direction of blood-vessels, is practically the same as it was before. The sequestrum from a case of periostitis may always be recognized by its smooth external surface, and the rough worm-eaten part beneath, where it has been excavated and detached by granulations. In osteomyelitis this is of course reversed.

The amount of new bone thrown out depends (so far as local conditions are concerned) partly upon the intensity of the inflammation, partly upon the length of time the sequestrum is allowed to remain and act as a foreign body. In the most severe cases, the periosteum, like the compact tissue beneath, is killed at the first, and no new bone is formed: the shell is deficient over a great part of the gap, although there is usually a certain amount at either end. If this occurs in the tibia, the two extremities, provided the epiphysis have remained intact, sometimes form a connection with the fibula, and this, because of the increased weight it has to bear, becomes hypertrophied. If it is the femur or the humerus nothing can be done, except possibly transplantation: in one or two instances a bone has been built up by this. Even, however, in moderately acute cases portions of the periosteum usually slough, and deficiencies are left here and there in the new shell. These openings are known as *cloacæ* and they serve as channels to convey the pus from the interior to the sinuses, by which it is discharged through the skin.

FIG. 182.—Chronic Osteomyelitis of Lower End of Tibia. The section across the shaft was solid, and the medullary canal completely obliterated. Below, the bone is riddled with sinuses, which lead in all directions through it. It was amputated because of the disease of the knee joint.

Sometimes when the tension has been relieved by free incision at once, no necrosis at all takes place; the bone is exposed, bare and white, but as soon as the pus has free exit the inflammation ceases and the periosteum falls down on to its place again. Even in these, however, a very considerable amount of new bone is thrown out, leaving an osseous node which becomes absorbed very slowly.

(*c*) In acute osteomyelitis, if the blood-poisoning does not prove fatal, the same reparative changes take place; but in most cases restoration is much less complete. This arises from the way in which the sequestrum is locked in. If the periosteum and the outer portion of the compact tissue escape destruction, and if (as in chronic abscess) layers of sclerosed bone are formed around, the removal of the sequestrum becomes exceedingly difficult, no matter how insignificant the size. The longer the irritation lasts, the deeper it becomes buried; and in old cases the bone becomes hardened, rugged, and enormously thickened, over perhaps its whole length. Sequestra locked in in this way in early life often give rise to such persistent trouble that after many years of suffering the patient begs for amputation. It is not uncommon at the lower end of the femur: a discharging sinus is left on the outer or inner side of the limb;

one is enlarged, hardened, and perforated with suppurating channels; the joint, from repeated attacks of synovitis, is utterly disorganized; and the nt becomes a hopeless cripple (Fig. 182).

**Symptoms.**—The onset is usually very insidious, unless the inflammation elops in connection with an already existing attack of pyæmia; then it may in with a rigor. The first and most prominent feature is pain, at the begin- g flying vaguely all over the body, but soon settling down to one part, and oming intense, especially at night. The least pressure or the slightest move- nt makes it simply intolerable; and the limb is kept absolutely rigid, as if it re paralyzed, every contraction of them uscles pulling on the periosteum causes ch agony. From the commencement the prostration appears unaccountably at; the pulse is small and quick; the temperature begins to rise at once; and severe cases may reach 104° F. by the second or third day; the respiration is ried; the tongue and lips dry; the skin burning hot; the pupils dilated and ring, and the face peculiarly dusky. Delirium soon sets in, especially at night, d by the third or fourth day the general aspect is that of the most intense blood- soning.

The local signs depend upon the situation. If the bone is superficial, as in e case of the tibia, the swelling can be detected at once; the skin soon becomes d and œdematous, and it is tied down to the periosteum beneath, so that it can- t move freely over the bone. On the other hand, when it is the femur, pecially when the back part is involved, they are much more obscure: the skin mains white until pus has formed and worked its way near the surface; often it whiter than natural, from the tension of the deeper structures beneath, with ightly enlarged veins passing over it; and no swelling can be distinctly made t. Usually, however, if the limbs are compared, the affected one looks more en in outline and more rounded than the other; the intermuscular depressions e partly filled up; and at the same time it feels more tense and firm, especially er the part where the pain and tenderness are most distinct. The temperature, o, is higher than that of the opposite limb; and if the inflammation is near a int there is always a certain degree of synovitis. In osteomyelitis the difficulty diagnosis is even greater than in periostitis; the constitutional symptoms are uch more severe; the local signs much less distinct.

Later, when the pus has escaped from under the periosteum and spread into e tissues around, there is little or no difficulty. Dusky erythematous patches ake their appearance upon the skin, the swelling becomes more distinct and calized, and deep-seated fluctuation is usually plain, especially if the patient is nder an anæsthetic. The constitutional symptoms do not begin to subside until e pus has been evacuated.

When the medullary canal is involved the patient may sink from acute septi- æmia before any local signs other than tenderness and pain have time to develop. f this does not happen various complications set in, according to the direction in hich the inflammation can extend most easily. Acute suppurative arthritis is one f the most common, the inflammation spreading through the cancellous tissue of e epiphysis, or outside it along the fibrous covering. Separation of the epiphysis another, causing deformity and a peculiar soft kind of crepitus when the limb is oved. In severe cases other bones may be involved, one after another being ttacked at intervals of a few days in distant parts of the body; sometimes each utbreak is attended with a rigor, more frequently pain is the most prominent mptom, and the swelling is only detected on examination. Secondary attacks f this kind are rarely so deep or so extensive as primary ones. Fatty embolism probably nearly always present, and finally pyæmia with metastatic abscesses may ccur, the pericardium being involved with singular frequency.

**Diagnosis.**—Acute suppurative osteomyelitis or periostitis may be mistaken r typhoid or other acute specific fevers, especially when the septicæmic symptoms re very strongly marked and fugitive erythemata are present upon the skin, but

careful examination can hardly fail to reveal a local cause. Occasionally it is taken for diffuse cellulitis, which, however, unless it is due to a poisoned wo rarely or never occurs in children; and sometimes for acute rheumatic fe especially when the lower end of the femur is involved on the posterior surfac that the knee joint is filled with fluid from the first.

**Treatment.**—*Division of the Periosteum.*—Whenever there is a suspi of acute suppuration in connection with bone, the patient should be placed u an anæsthetic, and an incision made through the soft parts and the periosteum to the surface of the compact tissue, selecting the spot at which the tenderne most marked. It is certainly not advisable to wait for a distinct sense of fluct tion; the pus may separate the epiphysis from the shaft, or detach the periost from almost the whole circumference, before it forms a sufficiently thick layer fluid for this. The extent of the incision depends upon the condition of the p osteum; if it is only just separated from the bone beneath, a simple linear divi may answer all requirements, free exit being provided for the effusion by means a large drainage-tube. If, however, the separation is more extensive, the finger a probe must be passed down to explore the surface thoroughly, so that count openings may be made where required.

*Drainage of the Medulla.*—Sometimes the symptoms are relieved at once, temperature falls, and it is clear the chief indication has been fully met. T limb must be kept perfectly quiet upon a splint, careful watch made that the ope ing does not close too soon or become valvular, and the periosteum will fall do on to the bone again, and very possibly there will be no necrosis. In other ca there is but a very short respite or none at all; and it is clear that further explorati is required, that the separation of the periosteum was not the primary affecti but merely an indication of more deeply-seated inflammation. This is especial likely to happen when the chief seat of tenderness is close to the epiphysial lin and when there is at the same time effusion into the neighboring joints; under these conditions it is more than probable that the inflammation involves, if it did not begin in, the layer of soft vascular growing bone on the end of the shaft, and that, if it has not done so already, it will almost certainly spread to the medullary canal. It is this form of necrosis which, if left to itself, leads to the death of the whole shaft and separation from the epiphysis at both ends. Under these circumstances, or if the epiphysis is already separated before the incision is made, the central canal of the bone must be opened and drained as well. When the connection is already severed the end of the diaphysis may be removed at once; with the medullary canal containing pus, with pus under the periosteum, and suppuration between it and the epiphysis, that part of the bone will certainly perish if it has not done so already. By this free drainage is gained at one spot; but that is not enough; an opening must be made into the central canal lower down on the bone, so that it may be thoroughly washed out. As a rule there is no difficulty in ascertaining the proper situation for this, for in such cases the disease is always far advanced, and either there is at some point extreme tenderness on pressure, or the periosteum is already detached and suppurating, the pus having worked it way out through the shaft along the course of the nutrient vessels. Then the cavity must be syringed out thoroughly with an antiseptic solution, the medulla itself removed as far as possible, iodoform dusted in, and a drainage-tube passed through. In one case in which this was done, by Jones, of Manchester, the whole of the shaft of the humerus was drained, from its upper extremity where it faced the epiphysis to an opening made a short distance above the inner condyle.

*Subperiosteal Resection.*—In the most acute cases, owing to the extreme rapidity with which the disease progresses, the time for this is already past. If the inflammation involves the periosteum only, free incision must be made down to the bone wherever fluctuation can be detected; if the medulla, and if the shaft is already detached at the epiphysial line, the whole of it had better be removed at

ce. This, which has been called *subperiosteal resection*, is most easily accomished by dividing the bone in the middle with a chain saw; the two halves can n be readily twisted out. It relieves the limb at once of what is practically a reign body keeping up a very great deal of irritation; it lessens the danger to e neighboring articulations, and it obviates the necessity for a long and tedious eration afterward when the new shell of bone has been formed. An extra ount of care, of course, is required to support and protect the limb until the w bone is sufficiently firm.

Other treatment is of little or no avail. Iodine and counter-irritants are orse than useless; they simply waste valuable time, and the same may be said f iodide of potash. Quinine and antipyrin may be given when the temperature very high, but they have little or no control over the disease itself. Afterward, ring the long period of exhausting and wasting illness which not unfrequently llows, the former, with preparations of iron and cod-liver oil, is often indispensble.

The limb should be kept at perfect rest upon a suitable splint, especially in hose cases in which, owing to separation at the epiphysial line, or to the early emoval of the sequestrum, the central support is lost, and sometimes it is necesary to maintain a slight degree of extension to prevent too much shortening. Cold applications, lead and spirit lotion, for example, may be used at first; but as soon as there is an escape for the pus, warmth is more serviceable, as the object hen is to encourage the discharge of the poison as far as possible.

Careful watch must be kept that the pus does not collect in the deep outlying ecesses of the part and undergo decomposition, especially as when dead bone is present it is often peculiarly offensive. Counter-openings are often required, and drainage-tubes must be used freely. If the neighboring joint becomes involved, it must be laid open thoroughly on both sides (and in the case of the knee behind as well) and freely irrigated. Even after this has happened the limb may be saved in exceptional instances; the upper epiphysis of the tibia, for example, has been removed, with some of the shaft, leaving a shortened limb riddled with sinuses, but capable of bearing some weight; nearly always, however, hectic and profuse suppuration set in; the cartilage becomes eaten out by granulations springing from the opposite bone; starting-pains make their appearance at night; the patient becomes exceeding emaciated, and amputation is necessary to save life.

*The subsequent progress*, if pyæmia and other complications do not set in, is dependent upon the situation and extent of the sequestrum. Sometimes, as already mentioned, it is completely separated within three weeks or a month: the line of demarcation corresponds to the soft vascular bone at either end, no time is required for absorbing compact tissue, and the whole shaft, even of such a bone as the tibia, can be extracted entire, leaving behind a great space lined with periosteum, which rapidly becomes filled with new bone. In other cases the time required is much longer, and in some exceptional instances it may be a matter of years, owing, in all probability, to the density and hardness of the surrounding osseous tissue. In young subjects the process is naturally much more rapid than in old, and it is somewhat quicker when the bones of the upper extremity are concerned.

Where the periosteum only is concerned and the sequestrum is small and superficial, it may separate of itself and be discharged through an opening in the skin, by what is known as exfoliation, without the necessity for any further operation. This is not uncommon on the skull (after injury, for acute necrosis rarely affects the flat bones) and on the subcutaneous surface of the tibia. A line of rarefying osteitis gradually forms around the dead part, the compact tissue that immediately borders it becomes more and more open; at length it is completely absorbed, and the sequestrum is left resting on the surface of a bed of granulations. No new shell on the outside is ever formed by the pericranium to lock the dead bone in, and very often it is almost as defective on the tibia, owing to the

thinness and the peculiarly exposed situation of the periosteum. As soon as line of demarcation is complete, the sequestrum is held in merely by the s and only requires the application of a pair of forceps to remove it. In t cases in which no outside shell is formed, whether on the skull or elsewhere, deficiency in the bone is rarely made good: the granulations gradually fill up hollow and become organized, and the deeper layers become converted into bo but the superficial part rarely passes beyond the stage of fibrous tissue. There no doubt the periosteum is the main agent in reproduction, although it may be the only one.

In central necrosis, on the other hand, or when a shell of new bone has be formed around the sequestrum, enclosing it and locking it in, extensive operatio may have to be undertaken for its removal. The longer it is left after it has co become loose, the deeper it becomes buried and the more serious the changes th it induces, not only in the other structures near, but in the patient's general co dition. The acute fever may have subsided long since and there may be only slight evening rise of temperature; but this, if continued, especially if connecte with bone, is very prone to end in either hectic or amyloid.

In the case of compact tissue it rarely happens that the living bone ca separate itself from the dead under two or three months; total necrosis is a apparent exception, but in this the line of separation runs along the soft vascul growing layer. During this time the appearance of the limb changes very co siderably. The heat and swelling of the acute stage gradually become less and less; the redness fades away, there is no longer such extreme tenderness on pressure, and the incisions, instead of gaping widely and giving exit to a mixture of pus and blood, gradually become contracted into narrow sinuses, lined with granulations and secreting only a small quantity of purulent fluid, which oozes slowly from a tiny orifice surrounded by a button-shaped mass of little vascular buds. A probe passed into the centre of this sinks almost of its own weight down a devious channel, until, after passing through one of the cloacæ, it comes into contact with the sequestrum. The utmost gentleness must always be used; if it is forced in any direction it is certain to catch somewhere against the walls, making them bleed, which they do with the greatest readiness, and causing pain.

The presence of a sequestrum must be gathered from the sensation the probe conveys; the hard, smooth surface, and the clear, ringing sound produced when a dead part is struck, differ completely from the soft, gritty sensation of carious bone, into which the probe can be driven with ease, and from the firm but roughened surface of uninjured periosteum. The size must be estimated partly from the position and direction of the sinuses, partly from the extent of the enlargement and the range of the original attack. Whether it is loose or not is very often a matter for conjecture rather than for belief; occasionally it is possible to move it slightly by firm pressure; or, by introducing probes into two distant sinuses and pressing on them alternately, to convey a kind of shock from one to the other; but very often the sole evidence is the peculiar hollow note when the sequestrum is sharply struck, and the length of time that has elapsed.

The operation itself (*sequestrotomy*) naturally differs in every case. A time for it should always be selected when the patient's temperature is as even as possible; it very commonly happens when there is a sequestrum of any size that slight attacks of feverishness occur from time to time, each one marking the formation of a fresh abscess in the neighborhood of the old inflammation. The limb should be raised to a vertical position for a few minutes and an elastic strap buckled tightly round it; or Esmarch's bandage may be used. It is of great advantage not only to control the hemorrhage at the time (and it is often very profuse), but to be able actually to see the condition of the bone. If the sequestrum is superficial, all that is necessary is to make an incision through the soft parts, either enlarging a sinus or connecting two that are close together, and twist it out with a pair of strong forceps; but when it is central a great deal of

nipulation may be required. Sometimes the cloacæ are large enough to allow o pass through: a very long sequestrum, for instance, from the tibia may, if ght fairly at the end, be extracted through a comparatively small opening. re often they have to be enlarged, or, like the sinuses on the skin, thrown into e, the intervening soft new bone being divided with a chisel or cutting-forceps, l, as far as possible, reflected without being removed. Occasionally, as in subiosteal resection, the necrosed portion can be divided with a chain-saw and exacted in two halves.

After the removal a smooth cavity is left, lined with granulations which bleed eely as soon as the bandage is removed. This may be checked to a certain extent washing out the interior with diluted tincture of iodine, or with very hot water, by packing it with some antiseptic dressing; but unless the cavity is of very rge size it is generally sufficient to bandage the limb carefully and keep it well ised: the bleeding only comes from capillaries which have been torn and have st their support; it rarely happens that a vessel of any size is divided. Afterard the wound must be washed out at frequent intervals with some antiseptic, as it is rarely possible to drain it effectually, and such an amount of blood, allowed to collect at the temperature of the body exposed to the air, might prove a serious source of danger. In a very few days the sides begin to fall in and contract; and as the granulations spring up and become organized, the amount of discharge grows less and less, until, in a comparatively very short time, the cavity is completely obliterated.

It is not always that the operation is so easy or is followed by such immediate success. In many instances the sinuses are surrounded by structures of such importance that only a very slight degree of enlargement is possible. Sometimes the sequestrum is not sufficiently loose, and only some of the superficial part can be chipped off or cut away; or it is so deeply buried that it cannot be extracted without almost cutting the bone in two. It is seldom that this happens as a result of acute osteomyelitis; but when the inflammation has been chronic (in quiet necrosis, for example, when a portion of bone near the centre perishes without causing suppuration) the compact tissue on the outside becomes thickened to such an extent that it is scarcely possible to make an opening of sufficient size. In other cases again the shell of new bone formed by the periosteum is defective, so that the limb is in great danger of what has been called spontaneous fracture. This may arise, as in subperiosteal resection, merely from the early removal of the sequestrum, and then in a week or two the limb becomes sufficiently firm; but occasionally it is due to sloughing of the periosteum. If it occurs in the tibia, the limb may still be preserved and prove of use, the fibula being assisted by means of an artificial support; in the femur, however, unless firm union can be obtained at the expense of the length of the limb, amputation must be performed.

All these difficulties combined are not unfrequently met with in necrosis of the lower end of the femur. The popliteal vessels, the external popliteal nerve, and the synovial membrane of the knee joint are all in danger; so that, unless the abscess is actually pointing elsewhere, the incision must be made in the outer side of the limb in front of and parallel to the biceps tendon. The sequestrum is very often only partially detached, even after years; if it is central it is exceedingly hard to extract before the knee joint is involved, owing to the immense thickening and condensation of the bone above and around it; if it is superficial and on the back of the bone (its usual situation), it is often in actual contact with the artery, owing to the absence or defective development of proper periosteal sheath: and instances of its having ulcerated through and caused fatal hemorrhage are not unknown.

Other troubles may follow at a later period. A certain amount of chronic osteitis is not uncommon; there are frequent attacks of tenderness and pain, especially at night; the bone becomes immensely thickened and irregular in shape; and occasionally, even after long intervals, residual abscesses form, probably from the slow decay and death of some of the lowly organized inflammatory exudation.

Sometimes sinuses persist for years, surrounded by dense, hard bone, and discharging a thin, purulent fluid from the granulations that line them. Minute sequestra not unfrequently become detached and slowly separate of themselves. In other cases the growth of the bone is arrested owing to premature ossification of the epiphysis; or the neighboring joint becomes stiff, and even at length practically useless from the repeated attacks of synovitis; and finally in some cases, even after the limb has been saved, amputation becomes necessary at last, either because the part is useless, or to save the patient from hectic or amyloid disease.

### *Acute Epiphysitis.*

This name has been given to a variety of acute suppurative osteomyelitis which attacks the bony nuclei in epiphyses, or more often the growing layer between the epiphysis and the shaft. Not unfrequently more than one bone is involved, and probably it is always pyæmic in character, but nothing is known with regard to any exciting cause, other than it is usually said to follow some slight injury.

The larger epiphyses (at the hip and knee) are most often affected, though the smaller ones are not exempt. In children it usually commences at the line of growth and spreads from there to the periosteum, or to the medulla, or to both together, leading to one of the worst forms of acute necrosis. In infants (and it is not uncommon within the first few months of life) it sometimes attacks the bony nucleus embedded in the centre of the cartilage, giving rise to what has been described as *acute arthritis of infants*. Suppuration sets in at once with the greatest intensity; the articular end of the bone becomes hollowed out into an abscess-sac, and almost always the pus bursts into the neighboring joint, destroying it completely. If the case does not prove fatal from blood-poisoning, or later from hectic and prolonged suppuration, the end of the diaphysis becomes united to the opposite bone, and the limb is left more or less flail-like, shortened and incapable of its proportionate share of growth. The upper end of the femur, for example, as soon as the child bears any weight upon the limb, becomes displaced until the trochanter is on a level with the anterior superior spine.

### *Septic Osteomyelitis.*

Acute suppurative osteomyelitis, after compound fractures or amputations in which the medullary canal has been opened, resembles acute necrosis very closely, though it differs in a few particulars. The infection, for example, is direct, through the wound, not through the blood; the pus is usually very offensive, and the tension, owing to the fact that there is a certain though an insufficient means of exit, is not so high.

Minute sequestra are of common occurrence after amputations. A ring of bone on the end of a stump is killed by the saw, or by the separation of the periosteum, and after a time is detached without causing any constitutional disturbance or giving rise to any more inconvenience than is due to the presence of a sinus. Sometimes the whole thickness of the bone perishes in this way just at the end. If, however, septic inflammation sets in and attacks the medulla, the result is very different. Masses of sprouting granulations project from the orifice; the central canal becomes filled with intensely infectious pus which cannot escape with sufficient freedom; the fever becomes exceedingly severe, the periosteum is stripped up from the bone, and if pyæmia does not set in and prove rapidly fatal, the whole thickness of the lower end of the bone, and the inner lamellæ for a very considerable distance higher, are killed. In this way the long tubular sequestra are formed which are sometimes extracted from suppurating amputation wounds. At the end where the inflammation is most intense, the periosteum and medulla are both killed, and the whole thickness of the bone perishes; higher up, the periosteum and the outer layers, being further removed from the central irritant, manage to

strum is worm-eaten all over by the
rest; higher up still, the sequestrum
regular spikes formed from the layers
4). Above this, and on the outer sur-
ganization goes on all the time, and
central canal, and sheathing the com-

entially the same as in acute infective
zed, and swollen; red lines run up the
sues on the inner side of the limb are
he wound separate from each other;
athed in pus, with the periosteum de-
lary canal filled with masses of sprout-
ncreases; frequently it pours out when
ne least it becomes offensive and the
iences with a rigor; the fever from the
ingly irregular, the pulse is rapid and
and brown, and the skin burning hot.
e is profuse diarrhœa; in other cases
osteophlebitis and metastatic abscesses
ng proves fatal before there is time for

mputations through the shaft, and they

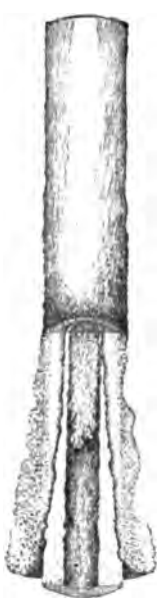


FIG. 183.—Section through Bone after Amputation, showing effects of Septic Osteomyelitis. At the end, medulla and periosteum have both been killed, and the whole thickness is dead; higher up, the periosteum, not being subjected to such tension, survived, and has thrown out a sheath of new bone; higher still, the medulla has been able to do the same.

FIG. 184. — Tubular Sequestrum from a similar case, showing the Smooth External Surface, where the periosteum was killed, and the rough, worm-eaten one detached by the granulations springing from the living bone.

lation at the hip.

### *Exanthematous Necrosis.*

Inflammation of the periosteum and the bone, followed by suppuration very often by necrosis, is not an unfrequent complication of the acute exan mata. Sometimes it occurs during the height of the attack, but much more quently it breaks out during the period of convalescence. In some instances probably pyæmic, originating by infection from some of the sores or ulcers; there is very often a history of its having followed a slight injury, and it certai is prone to affect superficial bones. It is quite intelligible that a trivial bruise, s as would not be noticed during health, might, under such circumstances, be f lowed by suppuration and sloughing. There is, moreover, very little tendency this form of necrosis to become diffuse, and the sequestra are usually small.

After typhoid fever it is not at all uncommon, especially on the tibia, a sometimes it is symmetrical; but it may also occur upon the ulna, scapula, pariet bones, or upon the ribs, sometimes ending in necrosis, sometimes clearing up. T jaws are more frequently involved after scarlatina and variola.

## Syphilitic Disease of Bone.

### (1) *In Acquired Syphilis.*

In all stages of acquired syphilis inflammation of bone is exceedingly common. Like the other manifestations, in the early period of the disease it is acute, attended with hyperæmia, but with only a slight amount of exudation; and it begins suddenly, runs a rapid course, and yields readily to treatment. In the later, on the other hand, it is much more chronic, the amount of exudation is larger, and caries and necrosis with suppuration are very prone to occur.

At the beginning of the secondary symptoms patients often complain of a feeling of soreness in the bones, sometimes amounting to actual pain, keeping them awake at night and flying all over the body, the so-called *osteocopic pains*. The bones are very tender, but there is no swelling and no increased heat over them. Probably, as the parts involved are those in which secondary syphilitic periostitis is especially prone to occur, they are due to a transient hyperæmia of the periosteum scarcely amounting to inflammation.

A little later, after the skin eruption, true periosteal nodes make their appearance. A slightly raised, exceedingly tense swelling forms upon the shaft of one of the long bones (the tibia, ulna, or clavicle particularly), or upon the skull. It is so painful and so tender, that the patient will not allow a finger to come near it, and at night cannot bear the contact of the bed-clothes. The skin over it is white and shining, from the way in which it is stretched; the temperature is slightly raised, and the whole bone is more or less tender. The size of the swelling is very small; there is no definite outline to it; it is very low and shades off gradually at the margin. Sometimes it is single; not unfrequently, however more than one bone is involved, and in the early secondary stage it is very often symmetrical.

The amount of exudation present in these cases and the changes it undergoes depend to a great extent upon the period of the disease. Nodes that are very acute are limited in size and attended with but a slight degree of small-celled infiltration, so that absorption takes place with great rapidity; the periosteum especially the deeper layer, is thickened, softened, and more vascular; the bone is scarcely affected, or it may be slightly too porous on the surface, and the swelling disappears under treatment without leaving behind any visible alteration of structure.

Those that occur later are more chronic, and affect the bone as well as the periosteum. The pain is not so intense, for the tissues have time to soften and yield; the amount of exudation is much greater in proportion to the hyperæmia;

the edges of the swelling are more distinct, and the bone underneath plays a much more important part. Rarefying osteitis sets in; the cancellous spaces are filled with syphilitic exudation, and even when resolution occurs comparatively early, some permanent alteration is usually left. The hyperæmia disappears, of course, and much of the exudation is absorbed; but a considerable proportion usually becomes organized and forms a permanent enlargement with dense osteosclerosis around it and under its base (*an osseous node*). The skull is an exception: pericranial nodes do not ossify; and if the external table of the bone is absorbed, the defect is not filled up (except with fibrous tissue) and the depression is permanent.

Later still, in the tertiary stage the amount of gummatous infiltration is very much greater, and it not only involves the superficial part of the bone, but spreads deeply into its substance, attacking the medulla both in the central canal and in the cancellous spaces. The swelling is much more chronic; instead of being superficial and limited, it may extend over the whole length and circumference of the bone; the Haversian canals are enlarged; the bony trabeculæ and the compact tissue are absorbed; and the medulla and the deeper layers of the periosteum are converted into a soft, reddish-yellow substance, which readily undergoes caseous degeneration. *Interstitial syphilitic osteomyelitis*, or what has been called diffuse gummatous infiltration, has been added to the periostitis. Sometimes, on the cranium for example, the exudation is greater in one part than in another; there is immense thickening along one of the sutures or over the eminences; but not unfrequently, especially when one of the long bones is concerned, the whole length is irregularly enlarged, thickened, and tender, and the soft parts and the skin around and over it are swollen and reddened.

Like gummata elsewhere, these tertiary nodes are much more lasting, and lead to much more serious results than simple periostitis. The exudation may be absorbed almost entirely; more often, especially at the edges farthest away from the chief focus, it becomes organized, and the bone becomes hard, heavy, and dense; in most cases, unless it is treated very soon, suppuration sets in; the skin gives way, the contents of the abscess are discharged, and the surface beneath is left bare and rough, necrosed and carious, according to whether it is compact or cancellous. In rarer cases the bone perishes, apparently from condensation, the Haversian canals at length becoming so narrow that the compact tissue is cut off from its blood-supply and dies.

On the cranium syphilitic nodes are exceedingly common. Early ones are soon absorbed; later ones are more chronic and leave depressions; tertiary ones that ulcerate and break down lead to the most extensive destruction. The vault is the favorite place; the whole of the exterior may be covered over with carious ulcers, varied here and there with patches which have undergone necrosis. Sometimes the external table only is diseased, although the internal always shows signs of increased vascularity; sometimes the whole thickness perishes, and more or less circular sequestra are formed. In most the ulceration is annular; the bone becomes rough and worm-eaten; a circular groove forms round it, and gradually the granulations grow beneath it and separate it from the rest. More rarely it is pitted; the compact tissue of the outer table is eaten away in little dots all over; and sometimes it is tuberculated here and there, nodules of new bone being formed, and subsequently in their turn becoming ulcerated and destroyed. Occasionally very extensive absorption of bone takes place without suppuration (Fig. 185).

Condensation and sclerosis more often affect the diploë and the inner table, particularly in the frontal region. The bone may become absolutely solid and hard all through, so that there is no trace left of cancellous spaces, and huge masses of dense osseous tissue may be thrown out on the inner surface, between the inner table and the dura mater (subcranial nodes). These are usually symmetrical, arranged on either side of the superior longitudinal sinus (Fig. 186). Suppurating gummata in the diploë are more rare; sometimes, however, they cause immense expansion, which chiefly affects the outer table and reduces the intervening tissue to a series of radiating bony bars.

FIG. 185.—Syphilitic Caries of Vault of Skull. There was no sign of suppuration or abscess; the bone was simply eaten away by specific caries.

The long bones are fected in the same way, cept that, owing to the co plastic function of the pe teum, a greater amount new tissue is formed upon surface. The early nodes acute and soon absorbed; l ones, involving the bones well as the periosteum, lea a thickening which very oft persists. In some cases, i which the deeper-lying osseou tissue and the medulla are e pecially concerned, the whol bone becomes hard and den (osteosclerosis); and occasion ally the formation of new tissu is so extensive that the Have sian canals become obliterated and the blood-supply of som of the central portion cut of If this occurs, and centra necrosis is added as a furthe source of irritation, the whol bone may at length become s changed in shape and density and so irregular upon the sur face, as to lose all resemblanc to its former self. This, how ever, is more common in con genital syphilis, affecting th tibia especially (hyperostosis) than in the acquired form.

In the tertiary stage, when the gummatous material is deposited in large quantities and has a greater tendency to caseation and suppuration, caries an necrosis are more common. Sometimes pus forms between the periosteum and t bone; the former is destroyed by the syphilitic exudation; no new shell is form upon the outside, the skin gives way, and the bone beneath is exposed, rough a soft upon the surface (caries), so that a probe can be pushed into it. Very oft the depression left appears deeper than it really is, because of the deposit of ne tissue by the periosteum round the edge. If the bone is deeply involved this m lead to spontaneous fracture. In other cases the exudation is more marked in t central and interstitial medulla; the whole bone is expanded and softened, so th when suppuration occurs and the skin gives way it seems as if it would be entire destroyed. This is not uncommon in the upper extremity, especially the forear That part of the limb is immensely swollen and thickened; the skin is redden and undermined with sinuses; the shaft of the radius or ulna, as the case mig be, is enormously enlarged, so that the size of the swelling appears almost entire due to the bone; and a probe passed into one of the sinuses can be pushed almost any direction. The appearance before suppuration sets in is almost ide tical with that of a rapidly growing sarcoma; but even in advanced cases reso tion and absorption take place readily under the influence of iodide of pota combined with tonics and good food. The same thing is not uncommon in co nection with the phalanges of the fingers and toes, both in the hereditary a acquired form, leading to a very great enlargement, of a peculiarly unifo shape. Occasionally it ends in necrosis.

The other bones are not exempt. The cervical vertebræ may be affected and [illegible] disease of the occipito-atloid, or atlo-axoid articulation. Gummatous deposit [illegible]y occur beneath the mucous membrane of the nose and lead to necrosis of the [illegible]al bones. Perforation of the hard palate (always exactly in the middle line) [illegible]d destruction of the nasal septum and of the turbinate bones are not uncommon. [illegible]e jaws may be affected, the upper more often than the lower, causing large por[illegible]ons of the alveolar margin to undergo necrosis, and leading to loss of teeth; and [illegible]is may occur in patients who have never taken mercury. In short, nearly every [illegible]one in the body may be affected to a greater or less extent, the changes being

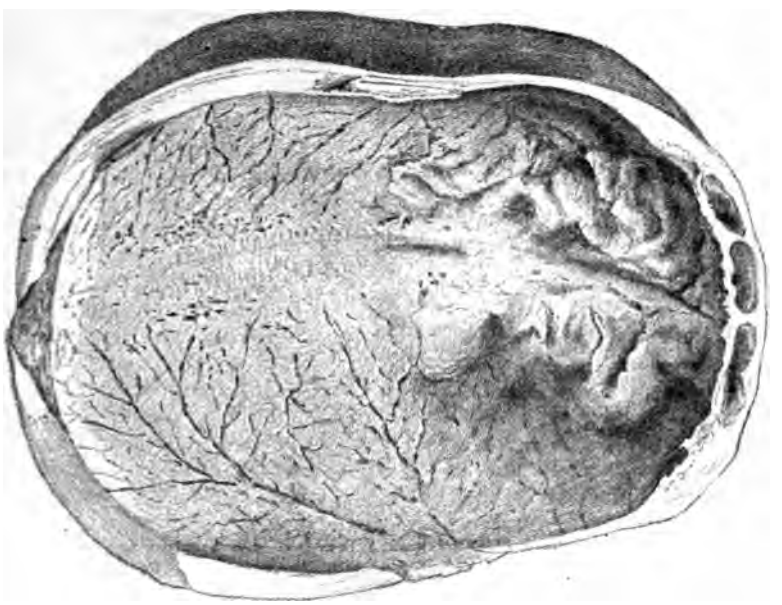


FIG. 186.—Symmetrical Nodes on Inner Surface of Frontal Bone. The diploë is filled in, and the grooves for the meningeal arteries are much too deep and too numerous.

practically identical in them all, depending upon the amount of the syphilitic exudation, the length of time it is allowed to destroy the bone, and the subsequent changes it undergoes.

### (2) *In Congenital Syphilis.*

Bone-lesions are very common in congenital syphilis, occurring *in utero*, during the first few months of infancy, and later at puberty, in the same way as the other manifestations. Those that appear in early infancy, and some of the later ones, are peculiar to the congenital form and are never met with in the acquired; but gummata, followed by caries and necrosis, occur as well, and cannot be distinguished from ordinary tertiary ones, except perhaps that they are more intractable and yield less readily to iodide of potash.

(*a*) The early changes are partly inflammatory, attended with new growth and the formation of fresh bone, partly atrophic, with wasting and degeneration. Not unfrequently, as in some other constitutional affections of bone, the two are found together side by side. As a rule they appear within the first year, often within the first three months.

1. The former chiefly occur under the pericranium and under the periosteum

of the shafts of the long bones. On the skull they are known as *Parrot's n* and are of themselves a lutely characteristic. T form four broad flatte bosses, sometimes half inch in thickness, surro ing the anterior fontan one on each parietal bo one on each half of frontal. Between them a deep crucial depressio corresponding to the s tures, and a skull marked this way is described "natiform." The centr of ossification are not in volved; the new bone orig inates in the deeper layer of the periosteum, and very often spreads down the su tures until it meets acro and bridges them. At firs it is very vascular and por ous, consisting of more o less perfectly developed horizontal lamellæ, united by trabeculæ running in a vertical direction; in the interspaces is a soft pulpy medullary substance, continuous through the widely dilated Haversian canals with that in the bone underneath. At a later period it becomes more dense and solid.

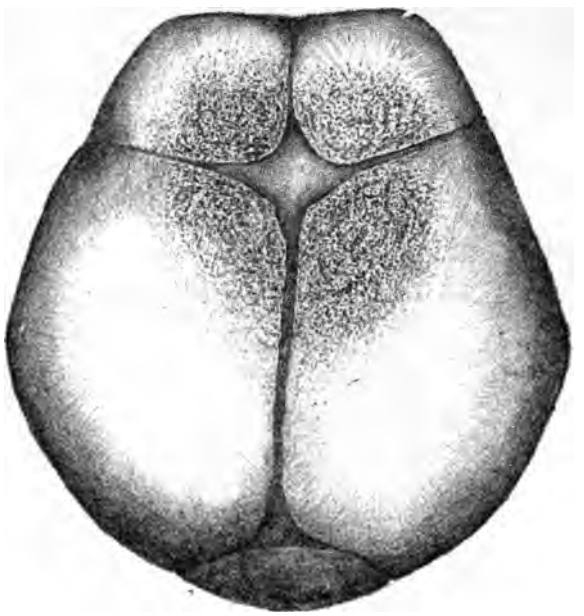


FIG. 187.—Parrot's Nodes Round the Anterior Fontanelle.

The shafts of the long bones, especially near the epiphyses, are not unfrequently sheathed in with a similar deposit arranged in layers around them, sometimes quite soft, and hardly ossified at all (the periosteum then separates more easily than natural), sometimes hard and dense. It may be associated with changes at the growing ends of the bones, but not necessarily so in any way. In some of these cases the medulla is found to be replaced and the central canal filled with a fine trabeculated, soft, spongy mass.

2. The atrophic changes (*gelatiniform degeneration*) are also met with on th skull under the pericranium (by which they can be distinguished from craniotabes which is simply a wasting of the bone under certain conditions from long-con tinued pressure), but the situation is not a common one. The favorite place at the ends of the long bones, especially of the elbow-joint, though none ar exempt. Strictly speaking the epiphysis is not affected, the disease attacks th growing layer at the end of the shaft and the cartilage (intermediary) that imm diately joins it. The medullary spaces in the growing bone increase enormousl in size; the new-formed vertical lamellæ waste away, the medulla itself become converted into a peculiar gelatinous mass ("like fluid jelly," whence the nam given it by Parrot), from which the cells disappear, leaving little but a fibrilla network with blood-vessels running here and there. In some cases there is layer of this soft semi-diffluent material, a line in thickness, between the cartilag and the bone. The cartilage itself undergoes a different transformation; th matrix becomes calcified to an abnormal extent, the cells are prematurely enclosed and the brittle vertical lamellæ rest upon the soft gelatinous layer on the end o the shaft.

In many respects these changes closely resemble those that occur i and the difficulty of distinguishing them is rendered greater by

two diseases not unfrequently coexist. Parrot's nodes, however, are distinctive.

The symptoms to which these changes give rise are very characteristic. A [illegible], puffy, tender swelling forms round the end of the bone, involving the joint; [illegible] limb is perfectly helpless (it has been called *syphilitic pseudo-paralysis of infants*), it bends and yields with the least pressure, and sometimes a certain amount of soft grating can be felt as if there was a separation between the calcified cartilage and the soft tissue at the end of the shaft. In the worst cases this does actually take place, and the end of the bone can be felt free and detached. Later, owing to the way in which the limb is constantly being hurt, as soon as the strength of the central support is lost, suppuration may set in, generally under the periosteum at the end, rarely between the bone and the epiphysis. Resolution under appropriate mercurial treatment is the rule, but not unfrequently premature ossification follows, and the growth and development of the body are arrested; not only does the size remain small, but the changes that normally occur at puberty are delayed. In the worst necrosis may follow, but such cases rarely survive sufficiently long.

(*b*) In the period between infancy and early puberty the bones, like the other tissues, are rarely affected. Gummata may occur, but they are not usual. At puberty there is a fresh outbreak.

The form this takes is in many instances as characteristic as the one already described. The shafts of the long bones, especially the tibia, are the parts most commonly attacked. Ill-defined periosteal nodes, not so acute as those met with in secondary syphilis, make their appearance on the skin; at first they yield to treatment fairly well, though a certain amount of thickening is always left; but they return again and again with the greatest obstinacy, and each time they resist absorption more and more. At first the periosteum only is affected, the superficial lamellæ are a little more vascular, but that is all; in a short time, however, the inflammation shows itself in the bone, and before long the whole of the shaft becomes thickened, bent (usually in exaggeration of the normal curve), lengthened perhaps, and covered over with great irregular bosses. On section the normal compact tissue can hardly be distinguished; the whole of the bone is dense and hard, immensely thickened and altogether altered in shape (*hyperostosis or interstitial condensing osteitis*).

Sometimes, when it occurs at an early age, I believe this is symmetrical, though usually one leg is much worse than the other; if it breaks out for the first time later in life (and it may not appear until two or three and twenty) this is not the case. In most instances the tibiæ are affected, but the bones of the upper extremity, especially at the elbow, not unfrequently suffer as well, and sometimes the clavicles, ribs, scapulæ, and other bones are attacked, too. Generally it is limited to the shaft, but it may extend to the epiphyses, especially the upper one on the tibia, and then it is always accompanied by synovitis, with effusion into the joint and thickening of the synovial membrane. In the milder cases suppuration does not occur; in the more severe ones, after the disease has lasted some little time, the syphilitic deposit under the periosteum perishes, and the bone is exposed at the bottom of an ulcer, bare, hard, and rough. The sequestra are usually superficial, but owing to the dense character of the bone beneath they often do not separate for years; and by the irritation they cause, and the assistance they get from pyogenic organisms, they lead at length to such an amount of solid œdema, ulceration, and sclerosis, that the limb resembles an old gnarled tree-trunk more than anything else.

Besides these, many other lesions are met with in congenital syphilis similar to those of the acquired form. Necrosis of the nasal bones and of the ethmoid is uncommon, leading to great deformity and attended with a profuse and inoffensive discharge from the nose; the whole of the frontal bone is somesed, bare, rough, and almost black; perforation of the hard palate in

the middle line is often met with; inflammation of the phalanges of the fin occurs occasionally; and in short there is scarcely a part of the body in wh the bones may not become the seat of gummatous deposit and perish, either minute fragments (caries), or in large ones (necrosis).

**Symptoms.**—Pain, heat, swelling, and redness are present as in other for of inflammation, varying very greatly in intensity. The first is the most co stant. In acute cases it is very severe, and like all bone-pain is much worse night and after exertion; the skin over the affected part is exquisitely tender; t patient will not allow a finger to come near it, and the whole bone when it percussed is highly sensitive. When the inflammation is more chronic this much less marked, but a dull aching sensation, becoming more severe under th same conditions, is rarely altogether absent. The amount of heat and redn depends chiefly upon the locality of the inflammation, whether it is near the surfa or not, and upon the presence of suppuration. Like the other signs, they ar much more severe when the attack is acute. The swelling is of great importance as the diagnosis of the cause depends very largely upon the locality and the pa of the bone involved. In the secondary stage the shafts of the long bones and the skull are affected, and the swelling is tense, circular, and very small, limited to one surface of the bone, chiefly periosteal. In the tertiary it is much larger and more chronic: the whole bone is involved; the swelling is uniform in shape, extending around, as well as along the shaft; and the same is true of the hereditary form when the long bones are attacked.

In children syphilitic nodes are very difficult to distinguish from the strumous or tubercular, especially when the metacarpal bones and the phalanges are concerned: the swelling is the same in shape, the other symptoms are the same, and often it is necessary to rely upon the other signs that are present. In adults, or when the long bones of the limbs are concerned (*e. g.*, the radius or ulna), there is not the same difficulty, as tubercle under these conditions is rarely met with, and does not, like tertiary syphilis, attack the compact tissue of the shaft.

As the inflammation extends, other signs make their appearance: suppuration may occur with caries or necrosis: an osseous node or enlargement of the whole bone may be left from organization of the exudation; neighboring structures may become involved, the joints for example may become inflamed, the cortex of the brain may be irritated or compressed, nerves and blood-vessels may be pressed upon; and in some cases the destruction is so great as to cause the most serious deformity.

**Diagnosis.**—Strumous nodes, as already mentioned, closely resemble those that occur in tertiary and hereditary syphilis, especially when the bones of the hand or foot are attacked. In each there is a chronic enlargement of the whole bone, with a tendency to break down and caseate, and in many instances it is only possible to distinguish one from the other by the history or the presence of other signs. Ulceration of the scalp with caries of the subjacent bone in children is generally tubercular, after puberty it is more often syphilitic, especially if it is attended with necrosis. In the case of the long bones tubercle nearly always begins in the cancellous ends, which rarely suffer in the course of syphilis.

Rheumatic nodes, leading to chronic osteitis, are still more difficult to distinguish. The symptoms in each are due to the condensation and sclerosis, and practically present no difference. Osteocopic wandering pains may occur in rheumatism as well as in syphilis.

Certain syphilitic nodes may, in some cases, only be distinguished from sarcoma of bone by the course of time, as the latter, and rapidly growing tumors are always accompanied by a certain amount of inflammation (periostitis and ostitis), a point to which attention must not be drawn until there is a very distinct degree of improvement. In doubtful cases it may be necessary to make an [illegible] with a trocar and cannula.

[illegible] nodes are a result of a surgical thing, hereditary syphilis is g

niotabes, enlargement of the epiphysial ends with thickening and bowing of shafts, and bending of the ribs are present in both; but as a rule in syphilis course is more acute and the disease not so uniformly distributed over the dy; the stress of the complaint seems to fall on one or two parts. Separation epiphyses and Parrot's nodes may be regarded as distinctive. In the latter ge the enlargement of the tibiæ, that is so common in hereditary syphilis, has en been confounded with the bending and the concavity that occur in rickets, t the enormous overgrowth in all directions, not in one only, and the irregularity the surface are never met with in the latter.

**Treatment.**—The treatment proper to the stage of the constitutional disease st be thoroughly carried out. Secondary syphilitic nodes yield at once to all doses of iodide of potash, but relapses are very common. Tertiary ones are s satisfactory; it is often necessary to increase the amount very largely before y effect is produced, and even then in some instances it is of very little avail by elf. Rest, warmth, tonics, good food, and fresh air are no less essential, espe-ially in inveterate cases, and not unfrequently when iodide of potash appears o fail altogether, it succeeds at once if the patient is sent to the seaside and made o lay up completely. The hereditary nodes that occur at puberty are still more intractable. The bone becomes sclerosed and dense, and nothing seems to have any effect upon it. In some of these cases, in which it is evident that the pain is kept up rather by the local condition than by the constitutional taint, linear osteotomy may be performed with advantage.

The inflammation that occurs in infancy must be treated with mercury in the same way as other infantile manifestations. The prognosis, if only one joint is affected, is good; if, however, there are several, or if suppuration occurs, recovery is very doubtful; rickets and visceral lesions are nearly always present as well, and even when the specific symptoms abate, the child generally dies from wasting and exhaustion, or from some comparatively trivial intercurrent disorder.

## Rheumatic Osteitis.

In chronic rheumatoid arthritis the bones become inflamed, as part of the joints, together with the other tissues. Atrophy and absorption take place to a certain extent along the line of pressure; and around the margin osteophytes are thrown out, dense hard masses of new bone, sometimes formed under the periosteum, sometimes due to the ossification of ecchondroses.

In addition to this, the bones themselves are liable to a form of osteitis, which, like rheumatic inflammation generally, tends to organization and sclerosis. Suppuration never occurs. The periosteal surface is roughened and irregular with outgrowths, the compact tissue beneath is exceedingly dense and hard, and the medullary canal is contracted. The changes, in other words, are typically those of osteosclerosis, exceedingly chronic, progressive, and attended with a considerable degree of aching pain which is worse at night and when exposed to damp.

Very little can be done for this condition; iodide of potash has scarcely any effect upon it, although it relieves the pain to a certain extent. Strong iodine liniment painted over the part, mercurial ointment well rubbed in, flying blisters and other forms of counter-irritation are often serviceable in the same way; the progress of the inflammation is stayed, and there is only the inconvenience arising from the increased size and weight of the bone. If this does not succeed, and the pain is severe, trephining, or linear osteotomy, according to the part of the bone involved, should be tried. Very often this gives perfect relief, apparently by diminishing the tension of the part, or by the subsequent changes that take place in the bone.

### Tubercular Osteitis.

This may occur either as part of a general disorder (acute miliary tuberculosis), or as an affection that is at first local and invades the surrounding tissues slowly, although under certain conditions it may become the source of a general infection. The former has practically no surgical importance, and does not admit of recognition during life; the latter is the same as what has hitherto been known as scrofulous disease of bone.

The cancellous tissue is the part chiefly affected, the ends of the long bones, the bodies of the vertebræ, and the carpus and tarsus; but it may occur upon the skull, and in children it often attacks the phalanges and the metacarpal bones. The shafts of the long bones of the limbs, the favorite seat of syphilitic disease, are practically exempt.

It begins, like chronic inflammation of cancellous tissue generally, as rarefying osteitis. The trabeculæ are softened and thinned at one spot; the medulla is replaced by reddish granulation tissue, round the margins of which typical miliary tubercles may be found, and this, in its turn, is enclosed by a ring of hyperæmia. Occasionally there are several of these close together, gradually enlarging until they coalesce.

The subsequent changes depend upon the activity of the bacillus and the power of resistance possessed by the tissues.

In some cases *caries sicca* sets in; the granulations continue to grow and increase without caseating or suppurating, and gradually the whole bone is absorbed and replaced by a soft, vascular mass, more or less representing it in shape, according to the amount of pressure it has to sustain. After a time this may break down and caseate, or it may slowly disappear, leaving a hard, shapeless, irregular mass of dense fibrous tissue and bone.

More often the granulation tissue in the centre becomes soft and yellow; caseation, followed by liquefaction, sets in, and a tubercular abscess (so called) is formed. Sometimes even then, if the nutrition of the part improves, sclerosis may take place around and enclose it; much more frequently the neighboring cancellous spaces become involved; the trabeculæ perish and fall off in fragments of various sizes (if they are of any dimensions it is known as *caries necrotica*), and a cavity is formed, filled with a caseous liquid mixed with debris and minute sequestra, and enclosed by walls of soft, carious bone, in the medullary spaces of which miliary tubercles may be found here and there. So long as these continue to form the softening spreads, until at length at some point it reaches the limit of the bone. If this is under the periosteum, further progress is often barred by thickening and condensation and the formation of new layers, so that the evacuation of the contents is checked. If it is near the articular surface, unfortunately this cannot take place; as the infection spreads the cartilage gradually becomes undermined, until it is detached or perforated by the granulations, and the tubercular material spreads at once over the synovial cavity.

When the compact tissue of the skull or of the other flat bones is involved, the changes are essentially the same, only, as might be expected from the structure of the part, necrosis is a more prominent feature. Sometimes wedge-shaped sequestra are found in the articular ends of the long bones, and it has been suggested that these are really due to embolism, the bacilli having been suddenly distributed over all the vessels of the affected region, and from their number setting up such an acute attack of inflammation as to cause necrosis. In the phalanges and metacarpal bones (rarely in the other long bones, even in children) the disease sometimes takes the form of expansion, giving rise to an enlargement apparently similar to that met with in syphilis, but without any sclerosis; there is a deposit of tubercle in the centre of the bone, spreading into the interstitial medulla of the shaft, and as the interior becomes hollowed out, layer after layer of vascular new tissue is formed under the periosteum, until at length the size of the part is more than double (*spina ventosa*) (Fig. 188).

**Symptoms.**—In tubercular osteitis these at the first are very vague and indefinite. If the bone is deeply seated, as, for example, the body of a vertebra, pain (often referred to the distribution of the spinal nerves), a little tenderness on pressure, and particular rigidity of the muscles around the part, are the only signs, until the loss of the tissue causes deformity. When it is superficial, the diagnosis is more easy; there is an ill-defined enlargement, due at first to thickening of the soft tissues and the periosteum, later to the expansion of the bone itself; but there is very little pain, even at night; tenderness on pressure is very slightly marked, and, unless the skin is involved, there is no rise of temperature perceptible to the hand, and no redness or pitting.

Later, as the inflammation extends to the neighboring structures and the area of softening enlarges, it becomes more easy. Neighboring joints become involved; at first there is simply an increase in the synovial effusion, due to the presence of a focus of inflammation near, but later, when the cartilage is perforated by the granulations, tubercular infection takes place, and thickening and pulpy degeneration follow. Characteristic deformity, shortening of the phalanges, for example, or angular curvature of the spine makes its appearance, and, when the abscesses break or are opened, sinuses are left, lined with tubercular granulations and leading down to soft, carious bone, into which the blunt end of a probe sinks with ease.

FIG. 188.—Radius from a Case of Tubercular Caries, showing what has been called an inflammatory expansion of bone, or spina ventosa.

**Diagnosis.**—Tubercular osteitis is met with in adults, and exceptionally in old age; but it is by far the most common in childhood and young adult life. In a very large proportion of cases there is evidence, either of the presence of tubercle elsewhere, or of a distinct constitutional predisposition, and not unfrequently the personal appearance is characteristic. So far as the local symptoms are concerned, the diagnosis rests chiefly upon the part of the bone involved and the peculiarly chronic and insidious character of the inflammation. The difficulty is greatest in the strumous dactylitis of children, which is very closely imitated by the syphilitic form. In the later stages the uniform character of the swelling, the whiteness of the skin, except at the actual point of suppuration, the soft, doughy sensation when it is pressed upon, the presence of caries, and the thin, oily character of the liquid discharged are distinctive.

The prognosis depends partly upon the constitutional predisposition of the patient, whether the taint is very strongly marked, partly upon the seat and intensity of the inflammation. Where, for example, there is a possibility of complete local removal before the surrounding structures are involved, or where caseation and liquefacation are delayed, and the granulation-tissue tends rather to organization, there is much better hope than when the bodies of the vertebræ are concerned and when the bone breaks down at once. Even then, however, although the destruction may be very extensive, the whole of the tuberculous mass may at length dry up and calcify or come away; and, as the patient's health improves, the process of softening and decay may come to an end, and give way to sclerosis and organization. Bony ankylosis, for example, may occur in the spine, even after the bodies of several of the vertebræ have been destroyed.

In a very large proportion of cases, the period of quiescence and organization unfortunately is only temporary. For the moment, under the influence of treatment, or owing to the patient's vigor of resistance, the spread of the tubercle is arrested and active repair sets in; but, unhappily, there is always the danger that, from slight local injury or from general failure of health, the disease will become active again and the inflammation commence afresh.

**Treatment.**—The constitutional treatment is the same as that required in

other cases of tuberculosis. Local measures must be guided by the situati the character of the inflammation. Rest is absolutely essential. The a blood flowing through the part should be perfectly uniform; venous co and transient hyperæmia are equally injurious. Cold is of great service, in checking the inflammation, but in arresting the growth of the bacill however, must be taken not to lower the vitality of the tissues too much. chronic cases counter-irritants may be used, iodine, blisters, and even th cautery, but not on the distal side of the disease or immediately over it, superficial, for fear of lighting up fresh mischief.

If, however, the disease is more active from the first, or if, from its sit there is reason to fear its extension to a joint or to some other important st it should, if accessible, be thoroughly removed, every precaution being t prevent its becoming more widely disseminated by the operation. The limb be raised; Esmarch's bandage applied to control, not only hemorrhage, sorption through the veins; the cavity freely opened (as far as possible w ting instruments, so as to avoid crushing or bruising) and thoroughly ev The granulations lining it and the soft, carious bone around it should freely cut away, and the wound plugged with iodoform gauze, or washed o an ethereal solution of iodoform. Afterward it must be kept as dry as po a proper system of drainage, and every precaution taken to prevent decom and suppuration. Carious bones in which sinuses are already present treated in the same way if they show no inclination to get well with measures. The os calcis, for example, may be entirely scooped out, leaving a periosteal shell, with an excellent result.

## Rickets (Rhachitis).

Rickets is a constitutional disorder, occurring in early life, and charac by a peculiar condition of the bones, affecting especially their epiphysia Other lesions are met with in the viscera in fatal cases, but this is the o that is universal and distinctive.

**Pathological Appearances.**—The changes are most marked in th ing portion of the bones; the older parts, those that are already firm a ossified, are but little affected in comparison, although there is in them a d tion of the earthy salts with enlargement of the medullary spaces and Ha canals.

The periosteum everywhere is thickened, softened, and too vascular; i away too easily from the bone beneath; the line of separation between the layer (the osteoid tissue) and the surface of the shaft is ill defined, and the of the latter is covered with laminæ of soft, porous bone. In between the rating them from each other, is a kind of fibrillated medullary substance; the cavities perhaps are formed afresh, but others are due to absorption part already developed and the enlargement of the interstitial medullary near the surface. In other words, the circumference of the bone continue large; the quantity of soft, organic material increases (actually, probably, as relatively); the amount of bone developed is very much less, and wh is, is deficient in lime salts.

Changes of a similar character take place at the epiphysial ends. No between the cartilage and bone, there is a narrow, grayish, semi-transluce visible to the naked eye, of cartilage that has undergone the transformati liminary to the development of bone. In rickets this layer is many tim thick, and, instead of being sharply and clearly defined from the bone formed, there are most irregular prolongations of it, penetrating deeply h there between the growing lamellæ beneath (Fig. 189). The microscopic a shows a similar change. The cartilage cells multiply to an altogether extent; the primary capsules are much larger than normal; and the cal of the matrix is excessive. Meanwhile, the soft medullary tissue in the

animals, is very unusual in man, and is so different that by many it is not considered due to rickets.

If the child is old enough to sit up, the vertebral column becomes distorted and bent. The head is usually thrown back, so that the spines of the cervical vertebræ are deeply sunken, and the whole of the dorso-lumbar regions form a great curve with its convexity backward. As a rule, this extends from the lower cervical region to the sacrum, and is perfectly uniform, so that there is no fear of mistaking it for the angular curvature of caries. Sometimes, however, it is very sharply marked, especially in the lower dorsal region, and the resemblance then is exceedingly close, especially as, at the same time, the muscles are rigidly contracted, owing to the pain that movement causes. In other instances, when the disease first begins at a later period, the natural curves may be simply exaggerated, or lateral curvature with rotation of the bodies may come on and end in the most extreme distortion.

The deformity the thorax undergoes (*pigeon breast*) is characteristic. The sternum is thrust forward by the ribs, partly from the increased curvature of the spine, partly from the yielding and sinking in of the walls of the thorax at the costo-chondral line. The chest is flattened at the sides (less so on the right, owing to the liver, than on the left); there is an abrupt bending inward of the ribs near their junction with the cartilages, leading to the formation of a groove on the antero-lateral wall of the chest, from the third rib downward and slightly outward, and at the lower border of the sternum this becomes continuous with a nearly horizontal constriction corresponding to the attachment of the diaphragm. In addition, the costochondral line is marked by a series of enlargements (the so-called beading of the ribs) analogous to the thickening and softening of the epiphyses on the ends of the long bones. Very often these nodes are so distinct upon the inner surface as to form distinct impressions upon the lungs and even upon the liver.

FIGS. 190 and 191.—Femur and Tibia Deformed by Rickets. The bones are exceedingly short (premature ossification of the epiphyses), the natural curves are much exaggerated, and the concavities are buttressed up with masses of dense, compact bone, arranged along the lines of pressure. This is best seen in the tibia, for the linea aspera is to a certain extent normal.

The brim of the pelvis is widened and flattened by the pressure of the abdominal organs from above; but the cavity is very much contracted, and at puberty is unable to assume characteristic development. The antero-posterior diameter is lessened by the projection of the sacro-vertebral angle, and the acetabula and the ischial tuberosities are pushed in from the sides, until it is forced into a trefoil shape. Occasionally laminæ of new, soft, porous bone are formed upon the surface similar to those under the periosteum of the scapulæ and the long bones.

Of all the long bones, the tibiæ are the ones that suffer most conspicuously. The curve is generally most marked at the junction of the middle and lower third; sometimes it is very sharp and strictly antero-posterior, the bone being flattened

from side to side until it is scarcely so wide across as the fibula; in other cases it is bent inward or outward as well, and overhangs the foot, the difference depending, in all probability, upon the age of the child, whether it is old enough to walk about of itself or is carried constantly upon its back (Figs. 190 and 191). The femur is always bent forward; the head is usually sunken, so that it is much below the level of the trochanter, and the linea aspera is exaggerated into a great buttress of bone toward which all the pressure lines converge. In the upper extremity, the amount of distortion is rarely so great; but the clavicles are sometimes very sharply bent, and the humerus and radius may be considerably bowed, especially when the child is in the habit of propping itself up upon its hands. In other cases there is little deformity of the shaft, owing to the fact that it carries no weight; but the lower epiphysis of the radius, no matter how slight the attack, rarely fails to show a certain degree of thickening.

The other pathological changes met with in rickets are less constant, but they are much more frequently the cause of death. Bronchitis and broncho-pneumonia with collapse of the lung are rarely altogether absent in fatal cases. There is usually evidence of gastro-intestinal catarrh, and the solitary glands and Peyer's patches are often unduly conspicuous. The liver is enlarged and very frequently fatty, often showing the marks caused by the ribs. The spleen is generally increased in size and is tougher and more dense than natural. The muscular system is ill-developed; the ligaments, especially in the latter stages, are lax and yielding, so that not unfrequently they become much too long; and, in short, there is evidence of general malnutrition affecting the whole body, though it only produces characteristic changes in the bones.

**Causes.**—Rickets may be caused by anything that impairs nutrition; it is possible that an excess of starchy food at a period of life when it cannot be assimilated is one of the most potent factors; but it is certainly not the only cause, and in no sense is it to be regarded as a specific one.

Weakly parents, in whatever station of life they may be, and whatever the cause, produce feeble children; and these, as they are almost always exposed to the same injurious conditions, become rickety. Distinct evidence of rickets (not fœtal rickets, which is probably entirely different) has been found in the fœtus and is not uncommon within a few weeks of birth, at a time when the ordinarily assigned causes, improper food, want of air and light, etc., can hardly have produced any effect. In the lower classes, frequent pregnancies and prolonged lactation, combined with the greater difficulty of obtaining proper food for a larger number, often reduce the health of the mother, so that the later children show definite evidence of rickets, while the earlier ones escape.

Artificial feeding, unless it is carried out with the greatest care and with especial regard to a child's requirements, will always cause it; and for this reason, among others, it is met with in all classes of life. It may, however, occur in infants at the breast when the milk is insufficient in quantity or quality; and it is practically certain if the child is suckled for too long a time.

Bad ventilation, want of fresh air and sunlight, overcrowded rooms, and neglect of ordinary hygienic conditions greatly favor its occurrence, not only by the direct effect upon the child, but by the way in which the health and strength of the patient become deteriorated. For this reason, it is much more common in towns where there is overcrowding than in the country. Syphilis, tubercle, and other disorders are very commonly associated with it; and they must be regarded as predisposing causes from the influence they have upon the health of the parent as well as upon that of the child. Rickets is not, however, in any sense of the term, directly produced by them.

**Symptoms.**—Rickets may be present before birth; craniotabes (occurring then on the inner side of the vertex of the skull owing to the position of the fœtus) and acute bending of the bones (infractions) have been found on many occasions; within the first few months of life beading of the ribs is quite common; after two years old it is rare for the disease to begin, though exceptional cases have

been met with as late as eight or ten. Sometimes, but by no means always, the children are miserable, wasted, and puny; in many instances there is nothing remarkable about their appearance; and occasionally it occurs in those that are apparently well fed, with plump, rounded limbs, of unusual size and weight for their age.

Sometimes it commences acutely; suddenly, almost from one day to another, the bones become tender, the contraction of the muscles exceedingly painful, and the child lies perfectly still on its back, afraid to move on account of the pain, and crying as soon as any one comes near. Occasionally the inability is so marked that such cases have been mistaken for general infantile paralysis. Much more commonly the onset is so insidious that it is impossible to assign even an approximate time. Profuse perspiration about the head, and throwing off the bed-clothes persistently at night; a rather large, square-shaped head; delay in dentition or inclosure of the anterior fontanelle; a prominent abdomen, with occasionally diarrhœa and very offensive motions, are all present in the early stages of rickets, and should always, especially when they occur together, excite grave suspicion; but they are not uncommon in perfectly healthy, well-fed children, who neither then nor afterward show any sign of the affection.

Enlargement of the epiphyses, especially of the wrist and ankle, beading of the ribs, and craniotabes may be regarded as definite signs. The child, to use the popular expression, is taken off its legs; it loses its liveliness, becomes peevish and fretful, and is only too happy if it is left alone; movement is attended with pain, the muscles become soft and flabby, the ligaments loose and yielding (double jointed), and if the back is involved, even the power of sitting up may be lost. Bending of the bones and deformity then begin to make their appearance; owing to the respiratory movements the thorax always suffers and becomes pigeon-breasted; and later, according to the age and habits of the child, the long bones of the limbs become affected.

Bronchitis, with collapse of the lung and broncho-pneumonia, is of common occurrence and may prove fatal; gastro-intestinal catarrh and diarrhœa are very often present, not unfrequently assisting as a cause; and according to Parker, no less than two-thirds of all the convulsive attacks to which children are liable (laryngismus stridulus, carpopedal contractions, tetany, strabismus, etc.) are due to or associated with rickets. Flat-foot, knock-knee, and lateral curvature of the spine, all of which are the outcome of weakness of the muscles and ligaments, usually, when the result of rickets, make their appearance at a later date.

**Prognosis.**—Except in acute rickets, which is not unfrequently fatal, the prognosis is, generally speaking, good. Bronchitis, convulsions, and diarrhœa must, however, always be regarded as very serious. In the vast majority of cases, although the growth of the bones is very liable to be checked, the deformity practically disappears, except so far as the thorax and skull are concerned; the pigeon-chest and the peculiar square-shaped cranium, if once thoroughly developed, persist through life. Probably the same is true, though perhaps not to the same extent, of the pelvis. In a few cases the bones never regain their normal outline; the neck of the femur is horizontal, and the shaft and that of the tibia are bowed; and in these the diminution of height, from premature ossification of the growing line, is always very distinct.

**Treatment.**—In most little more is required than careful attention to diet and the general principles of hygiene. In this respect the mother's health is of scarcely less importance than the child's. Cod-liver oil acts as a specific, and there are very few children, especially rickety ones, who cannot be induced to take it, or who do not even become fond of it. It should be given after food, and in small doses several times a day; large ones are more liable to create repugnance and may disagree. Iron is especially indicated where there is much anæmia. Lime, in the form of lime-water, is a necessary addition to the milk of most large towns, but by itself it has no power over rickets. The lactophosphate of iron and such preparations as Parrish's food are more valuable.

The diet must be as nutritious as possible, but at the same time well diluted, it may create indigestion and do more harm than good. For young infants, er's milk diluted according to the age, with milk sugar, and perhaps a few drops some pancreatic preparation added, is most suitable. For older ones, some of e artificial foods, the yolk of an egg, or, if the symptoms are very severe, a little w pounded meat, may be given; but even in them the chief reliance must be laced upon thoroughly good milk, in sufficient quantity, and cod-liver oil. A rtain amount of fresh fruit occasionally (the juice of an orange, baked apples, well-cooked potatoes) is of value, not only by assisting digestion, but by giving riety and checking any scorbutic tendency.

Fresh air, light, friction at night with oil and bathing (with sea salt if it can be procured) are almost as essential. The body should be kept warm, without being overclad; and especial attention should be paid to this at night, for fear of chills. Slight degrees of deformity may be trusted to get well of themselves; for them splints are of very questionable value; put on in whatever fashion they may be, they never can prevent an active child, conscious of recovering its strength, crawling about and propping itself up. In severer cases it is a different matter; in these they may be of service, not to put pressure on the limbs (this is only possible in cases of lateral bending, and even then very little can be done, owing to the delicacy of an infant's skin), but to keep the child quiet; and they should be suitably contrived for this. Bad cases of knock-knee, for example, may be placed in a box-splint with weight extension; but the apparatus must be removed at frequent intervals, that the limbs may be thoroughly rubbed and washed and the circulation through them encouraged. It is extraordinary the effect that simple rest in bed, combined, of course, with food, fresh air, cod-liver oil, rubbing and sea bathing, has upon the deformity of an infant's limbs. The health does not suffer in the least from the confinement; the muscles do not waste; the strength, instead of being impaired, seems to increase at an unusually rapid rate; and the weight being taken off the limbs, the bones and joints begin to straighten themselves out at once. Even in advanced cases, in which the thickening of the epiphysis and the beading of the ribs are less prominent than they were, the same may be tried with benefit for a time; if, however, the bones are definitely set and the sclerosing process is complete, it is rarely possible to correct the deformity without an operation.

### Acute Rickets.

Under this name a class of cases has been described by Barlow and others differing from ordinary rickets in several particulars, and probably associated with scurvy. It only occurs in artifically fed children, generally in the course of the second year; and it is characterized by the presence of extensive sub-periosteal hemorrhages, particularly on the femur, but involving other bones as well, even the beads upon the ribs. Later, when the acute stage is passed, the bones become enormously thickened, in all probability from the formation of a new periosteal shell around the extravasation. In some cases purpuric patches have been noted upon the skin; in others there were ecchymoses under the conjunctiva or in the eyelids; and in one the whole intestinal tract showed deep purple stains under the peritoneum, due to extravasation into the solitary glands and the adenoid tissue of the mucous coat.

The symptoms are very much more severe; in some cases they appear suddenly, in others they supervene upon the ordinary ones. The child is completely taken off its legs and lies flat upon its back, with the lower limbs slightly flexed and everted, utterly unable to move them (pseudo-paralysis). The pain is extreme; the thighs, which are usually the most affected, are swollen, tense, and shining; the skin is pale, but often warmer than natural, and the tenderness is so great that the child begins to scream as soon as any one approaches. The femur feels immensely thickened, and later, when the surrounding swelling has subsided, and the muscles are wasted, a dense solid casing can be made out around the bone,

either extending over its whole length or chiefly localized at the junction of epiphysis with the shaft. Soft crepitus can often be felt at the same time, as if epiphysis was detached. The legs may be affected as well, and even the bones the upper extremity, but rarely so badly. Before the disease commences there usually very great fretfulness; the anæmia is extreme; the muscles waste; the g are swollen and spongy in a large proportion of cases, especially around any that are newly cut; there is a putrid odor about the mouth; and not unfrequ marks of bruising can be seen on the body.

The prognosis of these cases is exceedingly grave; the same treatment be carried out, the limbs being protected from pressure and injury as far as po ble. In one instance an excellent result was obtained by cutting freely down to the bone, removing the blood-clot, and draining the cavity. It does not app to have been followed by further hemorrhage.

## Osteitis Deformans.

This name was given by Paget to an affection in which certain of the bones of the skeleton successively undergo a peculiar form of enlargement. It may com mence in one, generally the tibia, or in several; as a rule, it progresses slowly but steadily until all are more or less involved, the bones of the face and the hands and the feet being the latest. It is much more common in men than women; rarely begins before late in adult life; and may be symmetrical, though this is seldom exact. Respiration and locomotion are interfered with to a certain extent; the former by the changes in the spine and the thorax, the latter by the size and weight of the bones; so that the health frequently suffers, and patients have the aspect and attitude of extreme old age; but unless secondary complications occur it does not appear in any way to shorten life. In three out of the first five cases described by Paget, malignant disease of some type set in; and this has been observed by others, though not to the same extent. Whether there is any connection is doubtful; sarcoma and carcinoma have both been met with, sometimes involving the bones themselves, sometimes attacking other parts of the body altogether.

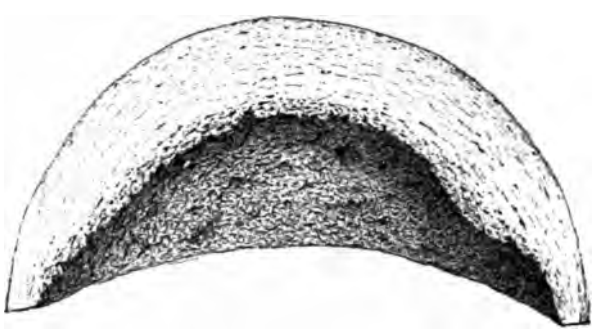


Fig. 192.—Section through Frontal Region of Skull from a Case of Osteitis Deformans.

Fig. 193.—Femur from a Similar Case.

The vault of the skull becomes enormously thickened, and at the same time uniform in character, the diploë disappearing completely (Fig. 192). The long bones increase in all their dimensions (Fig. 193); they become longer, thicker, and more irregular on the surface; at the same time they bend, and the curve involves the whole of the shaft, not as in rickets, the weakest part only. The spine sinks down in a most peculiar way, the head falling forward, and the back and loins forming one long, uniform curve, with the convexity backward. The thorax becomes rigid and distorted, so that the chest appears peculiarly short and narrow; and the pelvis widens out from side to side and diminishes from above downward.

The structure of the bone is at the same time profoundly changed. At first there must be a certain degree of softening to account for the alteration in shape; but this condition has not yet been identified. The compact tissue of the shaft and at the ends is especially affected and is replaced almost altogether by irregularly developed cancellous substance. The medullary canal is filled up more or less, and the periosteal surface is roughened and irregular.

The microscopic appearances are practically the same as in rarefying osteitis. The Haversian canals are enlarged and their walls eaten out with Howship's lacunæ; the innermost layer is soft, staining readily with logwood, and the medulla inside resembles that found generally in inflamed bone, only it is more fibrillar and less rich in cells. The bone-corpuscles are irregular in their distribution; the lacunæ small, shrunken, and provided with but few processes; and the concentric lamellæ exceedingly uneven in their arrangement; but there is nothing in any way distinctive and there is no change in chemical constitution. Here and there evidence of formative osteitis may be found, in the shape of greatly reduced Haversian systems. Sometimes it is associated with rheumatoid arthritis round the joint ends, but it does not appear to be connected with it. Bones in this condition have been known to break and to unite again without difficulty. No visceral lesions of any kind have been found, and there is no alteration in the urine.

**Cause.**—Nothing is known with regard to the cause of this complaint. It appears to be much more common in England, especially in London, than elsewhere, but in all probability this is accidental. Gout has been found to exist in some, but by no means a large proportion. In one or two instances it has apparently originated from injury; in others it has been associated with exposure to cold and damp. Certainly it is more common in infirmaries than is generally believed. It is peculiar that such a large proportion of the earlier cases should have ended in malignant disease; but as there was no uniformity as to the kind or even situation, this must probably be regarded as an accidental complication.

Hutchinson regards it as an infective osteitis excited by injury. It is distinctly inflammatory, usually originates in one bone, is not exactly symmetrical, and, what is especially important, becomes more rapid and involves other bones more extensively in proportion to its duration. At first the onset is slow, the changes very gradual, and the number of bones attacked few; later it spreads much more rapidly. For purposes of illustration, Hutchinson compares it with the disease

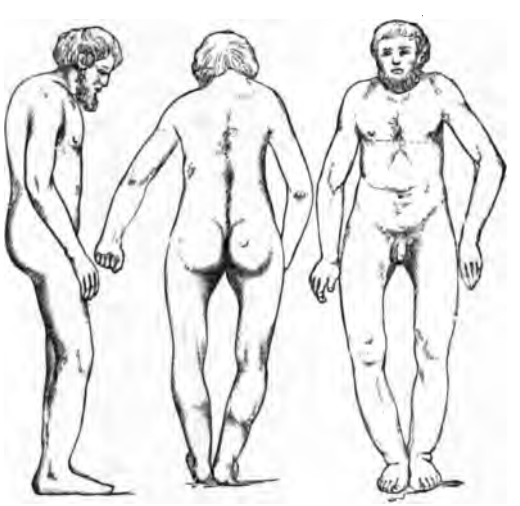


FIG. 194.—Attitude of a Man Suffering from Osteitis Deformans (Bryant).

known as granuloma fungoides. This begins as one isolated patch; progresses slowly at first; after a time leads to the production of others, and finally becomes malignant. It has been suggested on the analogy of acute multiple periostitis, in which secondary abscesses form one after the other on distant bones, that the products of inflammation of any tissue are, when circulating in the blood, infective to that tissue throughout the body; and the greater the number of centres for infection the more rapid the spread and the greater the risk of contamination.

**Symptoms.**—At first these are very obscure. Vague pains are complained of in one of the bones, not especially nocturnal or periodic in character, but sometimes in the early stages rather severe. The head is never affected by them; it simply increases in size, so that a larger and larger hat becomes necessary each year, without anything else being noticed. Then a certain degree of enlargement, generally a bowing forward of the tibia, is detected, and after perhaps an interval of years, one bone after another becomes involved, until the whole skeleton is distorted.

In advanced cases the attitude and aspect are characteristic (Fig. 194). The skull is massive and of enormous size, the head is carried forward and lowered until the chin is an inch or more below the top of the sternum. The neck is shortened, rigid, and bent forward, so that it is impossible for the patient to look up. The diminution of height is most striking; the whole spine is sunken and bowed, and even six inches may be lost. The shoulders are raised and very round; the arms appear of immense and disproportionate length, so that the hands reach below the knees. The chest is short and narrow, the abdomen broad and protuberant; and respiration entirely diaphragmatic; or if a deep breath is taken, the whole of the upper part of the trunk is raised. The lower limbs are strangely thickened, curved outward, and held apart, one usually a little in front of the other; the toes are turned out, the ankles overhung by the legs, and the gait slow and awkward.

**Diagnosis.**—In the early stage the symptoms very closely resemble those of rheumatic osteitis, but the pain is rarely so severe; afterward the deformity is characteristic. Enlargement of the bones, sometimes attended with bowing (especially in the legs), is met with under other conditions, but the diagnosis is rarely difficult. Simple hypertrophy, for example, without alteration in proportion, is not uncommon in the young, arising from overuse or from lymphatic obstruction; and great overgrowth may occur in inflammation dependent upon necrosis, syphilis, etc.; but the structural changes in the bones, the conditions under which they occur, and the course they pursue are entirely different.

In osteomalacia the skull sometimes becomes increased in size, but it is brittle, soft, and light, with abundance of medullary substance. A similar condition has been met with in rickets, very rarely in man, commonly in animals (Bland Sutton). The bone is described as becoming enormously thickened, but it is light, almost friable, and not porous on the surface: when touched it feels like fine cloth or felt. The membrane bones in particular are affected, and the change is not limited to the skull, but extends to the face, leading to closing of the orbits, filling up of the antrum, and atrophy of the optic nerves from pressure in the optic foramina. In leontiasis ossea, the growth, which usually involves the jaws as much as or more than any other bone in the head, is more irregular, and partakes rather of the character of exostosis than of simple enlargement.

So far as treatment is concerned nothing that is yet known appears to have the least effect. Iodide of potash is entirely useless, even for relieving pain, fortunately this is rarely severe, and the disease does not appear to

## Osteomalacia—Mollities Ossium.

This is a disease of adult life, in which the bones become softened to such an extent that they may be bent in almost any direction. It is very much more common in women than in men, and appears in many instances to be associated with child-bearing, especially with frequent pregnancies. Often it commences during the course of one of them, or shortly after childbirth; and when it occurs under these conditions it nearly always attacks the bones of the pelvis and the lower part of the spine. Under other circumstances the lower extremities are usually the first to suffer; and occasionally it remains limited to them. In most it involves one part after another; the patient becomes absolutely helpless; the cranium is thickened; infractions of the ribs and the bones of the extremities occur; and the walls of the thorax are softened to such an extent that respiration can hardly be carried out

Osteomalacia is apparently an affection of the medulla occupying the central space and the Haversian canals. It seems at first to be converted into a small round-celled growth, so vascular that hemorrhages take place in it everywhere. The bone in contact with it is softened and removed; the earthy matter disappears; the organic matrix is left with only a faint indication of lacunæ or canaliculi; and this in its turn undergoes a kind of gelatinous transformation until there is nothing but a soft, thin shell under the periosteum, filled with a pulpy substance incapable of the least resistance. Sometimes this is so mixed with blood that it forms a reddish-brown semi-solid mass, resembling the substance of the spleen; in the later stages it undergoes fatty degeneration and becomes converted into a pale yellow gelatinous material containing large quantities of serum.

Nothing is known with regard to the cause; it appears to be endemic in certain localities, but sporadic cases, especially those affecting the pelvis, occur everywhere. Great general nervous depression is stated to have been present in a large proportion before the softening showed itself. No certain visceral lesions have been found, and with the exception of the urine, which at certain periods of the disease is loaded with lime salts, even forming calculi, there are no symptoms other than those that result from the softening of the skeleton and the consequent deformity.

Deep-seated aching pains, not unlike those due to rheumatism, are usually present, and as a rule are worse at night and after exercise. At the same time there is a sense of weakness and of inability to make any exertion; standing particularly is attended with pain; but there is nothing definite and no diagnosis is possible until some alteration in shape is detected. The particular kind of deformity depends upon the circumstances of the case; the sides of the pelvis and the promontory of the sacrum may be crushed together until the cavity is almost obliterated; the spine may be bent almost double; the ribs and the walls of the thorax driven, and perhaps broken in, until the arms lie in two great hollows; or the bones of the extremity softened to such an extent that they can be made to assume any direction with the least pressure.

The disease does not appear to shorten life, except by the complications it causes. In a large proportion of cases death has occurred in connection with parturition; occasionally, when the skull has been involved, cerebral symptoms have set in; more frequently, owing to changes in the spine and ribs, respiration has gradually become more and more difficult, until at last hypostatic congestion and pneumonia have followed, and in a few paraplegia has occurred. If no complication of this kind makes its appearance the health gradually becomes more and more impaired from confinement and interference with digestion and the other functions of the body, until at length the patient sinks from exhaustion. Occasionally the disease remains stationary for a long time, and some instances of recovery, especially when it has been limited to the pelvis, are known; but no treatment appears to have any effect upon it. Recently, however, a case has been

[illegible] ich the symptoms disappeared after the ovaries had been removed.

A few cases are recorded in which osteomalacia has occurred in childhood (Davies Colley) and in infants (Rehn). The diagnosis from rickets is in some circumstances exceedingly difficult; and this has led some to the opinion that the two diseases are essentially the same, occurring under different conditions. In osteomalacia, however, there is no enlargement of the epiphyses or periosteal thickening, as in rickets; and the course of the disease and the effect of treatment are entirely different.

## TUMORS OF BONE.

Tumors of bone are either simple or malignant, though the degree of their malignancy varies within very wide limits. The former comprises the fibromata, osteomata, and enchondromata, springing from the substance of the bone itself or the tough tendinous layer of the periosteum, and composed of what might be called adult tissues; the latter are all of them sarcomata, round-celled, spindle-celled, myeloid, or mixed, without any predominant element, and arise either in the soft vascular medulla (central or interstitial) or in the corresponding tissue in the deeper layer of the periosteum.

### OSTEOMA.

Exostoses are of two kinds, ivory or cancellous. The former, which are chiefly developed in membrane, spring from the compact tissue of the flat bones, especially those of the skull, and are so named because of their density; their structure is that of true but exceedingly compact bone. As a rule, they are single and limited in size; but occasionally, especially when they occupy the frontal or nasal sinuses, they attain very considerable dimensions and cause the most terrible deformity (Figs. 195 and 196). Even when they are quite small they may, from

FIG. 195.—Exostosis of Frontal Sinus.

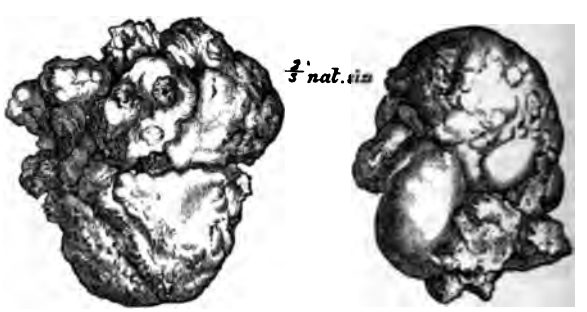



FIG. 196.
Ivory Exostosis from Frontal Sinus.

their position, in the external auditory meatus, for example, give rise to very serious inconvenience and even death.

Cancellous exostoses, on the other hand, are generally met with on the long bones. In many cases they are multiple and symmetrical, and then they are not unfrequently hereditary. As a rule, they occur in childhood, at the junction of the epiphyses with the shaft, especially in the neighborhood of the knee joint, and they continue to grow until the ossification of the bone upon which they are placed is complete. Generally they stop then, but occasionally, when they have appeared rather later than usual, they continue to increase, and, unless they are dealt with, form tumors of very serious dimensions. Unlike the ivory ones, they

developed from cartilage which gradually becomes converted into cancellous ue, continuous with that of the bone beneath. So long as y are growing a thin layer persists upon the surface like a p; afterward it becomes ossified and converted into compact ue continuous with that of the shaft.

FIG. 197.
Sub-ungual Exostosis

Single exostoses are frequently met with upon the linea pera of the femur and the supra-condyloid ridges of the merus, originating apparently in the fibro-cartilaginous tissue at marks the attachment of muscular aponeuroses. Very ten it is difficult to distinguish them from osteophytes, outrowths in the same region caused either by injury or by rheuatic inflammation. Another very common situation is the ernal surface of the last phalanx of the great toe, where they ve rise to the greatest inconvenience, from the way in which e nail is lifted up, first into a vertical position, and then rther still, until it grows back upon itself. Curiously, this particular form is uch more frequently met with in women than in men (Fig. 197).

**Symptoms.**—An exostosis, unless it presses upon some adjacent structure, merely forms a hard, painless enlargement of exceedingly slow growth. Not unfrequently a bursa is developed over it from the constant friction, and this may increase in size until it forms a communication with the neighboring joint. In other cases, however, the growth may prove a very serious matter. The eyeball may almost be forced out of its socket and the face hideously distorted by one growing from the frontal sinus or antrum. The external auditory meatus may be closed, so that the secretion collects behind and sets up inflammation. The brachial plexus may be pressed upon by an outgrowth from the transverse process of a vertebra. Cerebral symptoms may be caused by one lying on the inner surface of the skull. The use of a joint may be rendered impossible. The pericardium may be pierced by one growing from a rib, and, in short, there is hardly any structure near a bone that may not suffer.

**Treatment.**—In one or two instances an ivory exostosis has separated spontaneously; probably the bone at the neck became so dense that the blood-vessels were gradually obliterated, and it was shed like the antler of a stag. Such an occurrence, however, is rare. Whether it is advisable to attempt removal must depend entirely upon the symptoms; if there is no inconvenience it should certainly be left alone, as the operation, even though the neck of the growth is often very much smaller than the body, is not one to be undertaken lightly.

Many are so hard that it is impossible to make any impression upon them with an ordinary trephine. On several occasions they have been removed, only after the most intense suffering and repeated operations, by constantly applying acid to the base, so as gradually to cause necrosis. Probably the most effective instrument for the purpose is the surgical engine, with well-tempered steel drills, made to suit each condition. In the case of the external auditory meatus, for example, they should be guarded so as not to pass too far down. It is scarcely possible for any growth to resist this, applied under an anæsthetic, but it is as well to have a series of instruments at hand.

Cancellous exostoses generally stop growing when the skeleton becomes developed, but if an operation is necessary, the neck can, as a rule, be divided easily with a chisel. Various kinds of cutting forceps, and occasionally a chain saw, may be required. Removal of the cartilaginous layer only, in most cases, is sufficient to stop the growth, but if the tumor presses upon adjacent structures it is better to take it away entirely. Subcutaneous fracture or section of the neck has been recommended, and sometimes after this the growth atrophies and disappears, but not infrequently, in spite of all precautions, union takes place again. In the case of the subungual exostosis an incision should be made horizontally round the anterior end of the projection, and the nail with its matrix reflected; the growth can then be excised and the nail replaced in its natural position.

## Enchondroma.

Cartilaginous tumors grow from the long bones at the junction of the epiphysis with the shaft, from the phalanges and metacarpal bones of the hand (the feet more rarely), and from some of the flat bones, especially the pelvis and scapula. Not unfrequently they are multiple. In some cases they originate in the centre and cause the bones to expand evenly into a thin shell, which ultimately disappears in places; more often they grow from some point in its substance or immediately under the periosteum (Fig. 198); occasionally there are several separate foci, and in some exceptional instances the tumor appears to be diffuse, involving more or less the whole structure of the bone at one point. In addition enchondromata sometimes originate from the exterior of the periosteum and by their pressure cause absorption of the bone on which they lie.

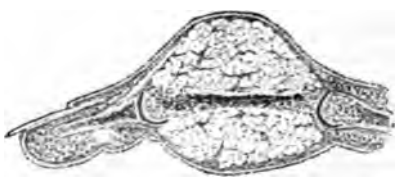


Fig. 198.—Enchondroma Springing from Surface of Shaft of Phalanx.

Some are composed almost entirely of hyaline cartilage, with but little fibrous tissue, and soon become ossified into cancellous exostoses. Others, especially those on the phalanges, become calcified in parts, or converted into mucous tissue, or undergo cystic degeneration, so that they are filled with cavities containing a thin glairy fluid. Their growth is always exceedingly slow. If, particularly in the case of a tumor attached to the surface of a flat bone, progress is at any time rapid—if, for example, it has doubled its size within the year—it must be regarded with very grave suspicion, as it is very likely to turn out, not a true enchondroma, but a chondrifying periosteal sarcoma, the prognosis of which is exceedingly bad.

Enchondromata are much more common in the young than in the old; often they have lasted for years already before any attention is paid to them, and occasionally, especially when they grow from some inconspicuous place, such as the pelvis, they are allowed to attain an enormous size. They form smooth, rounded, or slightly lobulated swellings, the outline of which, though it may shade off into that of the subjacent bone, is always free from the other structures around; the skin and the muscles may be made to move over it without difficulty. Usually it has the peculiarly firm, elastic resistance of cartilage, but sometimes bony plates may be detected on the exterior, and occasionally it is plainly cystic. Central growths are fusiform in shape and no line of separation from the bone can be made out; sometimes parchment crackling can be felt. Superficial or peripheral ones are more distinctly rounded, projecting from the bone beneath, and if there is a pedicle are often slightly movable.

Fig. 199.—Enchondroma of Hand.

Except in the case of intrapelvic tumors the diagnosis rarely presents any difficulty. The most important feature is the extreme slowness of growth; unless some nerve is caught and compressed all the surrounding structures are gradually and painlessly pushed aside. Syphilitic or strumous enlargement occasionally presents a certain amount of resemblance, especially in the case of the fingers; but though it may not be very distinct, there is always some evidence of inflammation in these cases.

The prognosis, so far as the character of the growth is concerned, is very good; there is little doubt that the cases formerly

scribed, in which secondary deposits made their appearance within a comparatively short time, were really sarcomata, in which the greater portion of the growth had become converted into cartilage; but very great inconvenience and even danger may arise from the size, number, or situation.

The only treatment is the removal, if possible, of the whole growth, though in some cases portions have been left behind without causing further trouble. Whether this should be attempted or not must depend upon the circumstances of each case; if the tumor is not increasing in size, or is not in such a situation as to cause inconvenience or danger, it may be left, provided the patient is aware of the necessity for careful watching. When it is situated on one of the fingers it is often possible to excise the growth, leaving the bone from which it springs; even though there is merely a shell, it will become sufficiently consolidated to act as a support. If this cannot be done, and the growth is very unsightly, the finger must be amputated. The same plan may be followed with the large single enchondromata occurring in the other parts of the body; either excision or amputation, according to the situation of the growth and condition of the parts left after its removal; but occasionally, especially when it grows from the pelvis, this may be a matter of the very greatest difficulty; in one instance, for example, it became necessary to place ligatures upon the common and external iliac arteries and veins before the tumor could be removed.

### Fibroma.

Tumors composed simply of fibrous tissue are rarely met with, except in the form of naso-pharyngeal polypi, growing from the under surface of the base of the skull, and epulis springing from the alveolar border of the jaws. With a few exceptions they are always attached to the periosteum, and are more or less pedunculated. The diagnosis from enchondroma is rarely possible before removal. Fibro-sarcomata may be distinguished by their greater rapidity of growth.

### Sarcoma.

Probably all primary malignant tumors of bone belong to one or other of the varieties of sarcoma. Carcinoma never occurs except from secondary infection or direct extension. Like other sarcomata, they are met with at all ages, but are much more common in early life, and they are distinguished from all other tumors of bone by the rapidity of their growth. In many instances they originate after, and possibly because of, local injuries.

There are two forms fairly well distinguished: one growing from the deeper layer of the periosteum, the other from the medulla, either of the central canal or of the cancellous ends. In addition periosteal growths are occasionally met with, originating from the exterior and extending into the substance of the bone. Few are composed of only one tissue, nearly all are mixed; but, as a rule, one kind predominates sufficiently to admit of their being classified as round-celled, spindle-celled, and myeloid or giant-celled. Secondary changes are often present as well: ossification and chondrification, for example, are not uncommon, especially in periosteal growths; myxomatous and cystic degeneration are of frequent occurrence in the central; hemorrhages may be caused by the most trivial degrees of violence, owing to the thinness of the walls of the vessel; and the extravasation is sometimes so extensive that nothing but a shell of solid tissue is left around the exterior.

The bones of the lower extremity are very much more frequently attacked than those of the upper, and the neighborhood of the knee joint is by far the favorite locality; but they are common upon the jaws (forming one variety of epulis), and they may occur upon any bone in the body.

Their malignant character is shown by the way in which they infiltrate the structures around, implicate lymphatic glands, and occasion secondary deposits in other organs, especially the lungs. In this respect, however, they present con-

siderable differences. Central ones, for example, confined within a shell of bo are much less prone to extend than periosteal; lymphatic enlargement is m more unusual in the spindle-celled variety than in the round-celled, and it is m more likely to occur in sarcomata of the pelvis than in those growing from a other part of the body.

Spindle-celled periosteal sarcomata are the most malignant, giant-celled ce tral ones the least so.

### 1. *Central Sarcomata.*

These grow from the articular ends of long bones or the cancellous tissue short ones. Sometimes they simply remove and replace the bone, keeping exac to the shape and size, so that the first definite sign is spontaneous fracture; mo frequently they cause gradual expansion, the compact tissue being absorbed fro the interior, and a new deposit being laid down under the periosteum, until a length a great shell is formed, more or less spherical in shape, smooth on the su

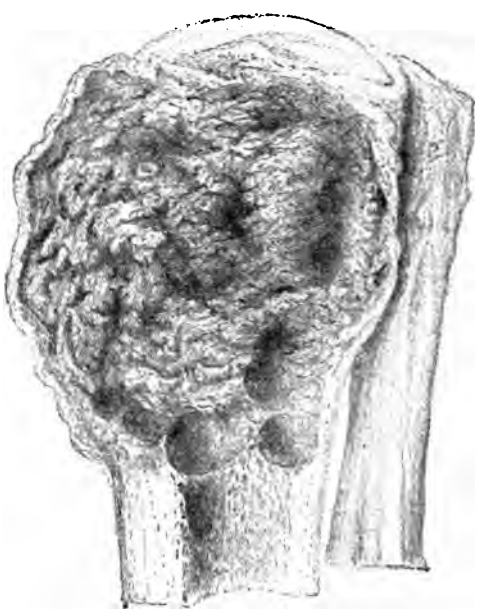


FIG. 200.—Central Myeloid Sarcoma of Upper End of Tibia. The articular cartilage on top is intact. Below are many cysts.

FIG. 201.—Myeloid Sarcoma of Upper End of Fibula, causing immense expansion of bones. The interior contained apparently nothing but blood until the wall was scraped.

face, and covered over with thin bony plates, which give a sensation of egg-shell crackling when pressed upon. The rate of growth is less rapid than that of the periosteal variety, but at length the casing gives way and the overlying soft tissues are invaded. The articular cartilage resists to the last, so that after the bone is removed it floats as it were upon a soft, yielding bed, incapable of withstanding the least strain; but unless it is torn accidentally it very rarely gives way of itself. Pain is often severe, especially at night; pulsation has been noticed in a large proportion, and spontaneous fracture is not unfrequent.

Giant-celled, round-celled, and spindle-celled forms may all occur; but the first is the most striking in appearance. Dark red, brown, or maroon-colored masses of myeloid cell are mixed here and there with whiter parts, in which the round or spindle cells predominate. Cysts are scattered all through the substance of the tumor, some containing a perfectly clear fluid, others filled with a soft, greenish, jelly-like material, the product apparently of myxomatous degeneration

Fig. 200), while here and there blackened patches from old hemorrhages, or right red ones from those more recent, add to the general variety. In some instances, which used to be described as blood-cysts, the hemorrhage is so extensive that there is merely a thin, bony shell filled with extravasated blood and lined with a film of sarcomatous tissue (Fig. 201).

The spindle-celled form has a tendency to attack the shafts of the long bones rather than the cancellous extremities, and assumes the shape of a rounded tumor, generally firm and elastic to the touch, and grayish-white and smooth in section. From its position it is peculiarly liable to lead to spontaneous fracture; local pain is felt for a week or two in the shaft of one of the bones, sometimes very severely; fracture suddenly occurs without any adequate reason; and a rapidly growing tumor forms at the seat of injury. It is in these cases that the diagnosis from quiet necrosis is so exceptionally difficult.

Round-celled sarcomata, when they occur in the medulla, are only to be distinguished from myeloid ones by their greater rapidity of growth; consequently in them the pain is more severe, pulsation more frequent, and the tendency to hemorrhage and invasion of surrounding parts more distinctly marked.

### 2. *Periosteal Sarcomata.*

These are either round-celled or spindle-celled in varying proportion; sometimes almost pure, sometimes evenly mixed. Giant-cells are generally present in the deeper parts, but not in sufficient number to form a separate class. Many of them are converted to a greater or less extent into cartilage or bone; and it is probable that most, if not all the tumors formerly described, from their malignancy, as osteoid cancer, malignant enchondroma and the like, were really periosteal sarcomata. They spring from the deeper, more vascular layer; and the tumor at first is confined to one side of the bone. The fibrous part is stretched over it so long as the growth is small; but as soon as it attains any size it bursts through this, invades the tissues around, and destroys everything, including the superficial portion of the bone (Fig. 202). Sometimes it extends into and rapidly fills up the central canal.

The consistence of the growth is very variable. In many instances it is simply a soft, pulpy mass filled with broken-down extravasations; in some it is much firmer and almost fibrous on section. The base is often partially converted into cartilage or bone; and the whole of its substance may be traversed by delicate osseous trabeculæ springing from the bone beneath, and forming a most elaborate skeleton. Cystic and gelatinous degeneration also occurs in patches here and there.

Periosteal sarcomata appear to be more common in the femur than elsewhere, commencing either on the shaft or the epiphysis; but there is no bone in the body that is exempt. They are all of them of the most intensely malignant character, affecting not so much the lymphatic glands (spindle-celled ones very rarely) but other distant organs; so that even if amputation is performed as soon as the diagnosis is made, the stump may remain healthy to the last, but secondary growths are almost sure to appear within the twelvemonth. The

FIG. 202.—Skeleton of a Periosteal Sarcoma Growing from Lower End of Femur; the epiphysis is not yet united.

liability to fracture, of course, is less than in the central variety; but the other signs due to the extension of the growth into the structures around are, as a rule, more distinct.

**Symptoms.**—In the early stages these are very indefinite. Pain is rarely absent; often it is very severe, especially at night. In the periosteal form a distinct swelling, projecting from one side of the bone, is one of the earliest symptoms; in the central it is rarely perceptible until the disease is far advanced; and when the growth commences in the interstitial medulla, at one of the cancellous ends, it is often entirely absent until the whole framework has disappeared. The outline of the enlargement is fusiform, spreading along the bone and ill-defined in the periosteal; in the central it is rounded and more distinctly limited. Its consistence is equally variable; sometimes it is soft and fluctuating; sometimes hard and dense, according to the character of the predominant tissue. Egg-shell crackling is only met with in the central variety.

Spontaneous fracture may occur in either, but it is less common in the periosteal. Occasionally it takes place without any evidence of tumor or new growth except pain; but the swelling rarely fails to make its appearance immediately after, and soon attains an enormous size.

Rapid growth, enlarged cutaneous veins over the tumor, softness, and above all pulsation, are most important. Any tumor attached to bone that doubles its size within six months must be regarded with very grave suspicion, particularly if it occurs in a young person and in the neighborhood of the knee joint. Pulsation is present in a large proportion of central sarcomata, and in periosteal ones, when they grow from the flat bones; and when it occurs it is practically definite. It is entirely different from the heaving impulse of an aneurysm; and though it may be accompanied by a distinct thrill and bruit, these are only present over a small portion of the swelling. The pulse in the limb below is unaffected unless the tumor compresses the main artery against the bone; and the swelling cannot be materially lessened by pressure.

If the diagnosis is uncertain the swelling should be explored without delay with a fair-sized trocar and cannula. In many cases this penetrates into the bone in such a way that there can be no doubt as to the change it has undergone; in others, myeloid cells, or other structures that can be recognized as sarcomatous, come away with the blood and can be recognized under the microscope.

**Diagnosis.**—Innocent tumors of bone are distinguished by the slowness of their growth, and by the absence of pain and increased vascularity.

Gummata occasionally presents some difficulty, as the history of syphilis does not exclude the presence of sarcoma. Any doubt, however, can usually be dispelled in a few days by the administration of iodide of potash. It relieves the pain of sarcoma, so far as this is dependent upon accompanying periostitis, but it has no effect upon the size.

When the sarcoma occupies the cancellous end of one of the long bones it may be entirely concealed by the symptoms of inflammation of the neighboring joint. This chiefly occurs at the knee; the position of the limb is characteristic of disease of the joint; movement is painful and limited; the synovial sac is filled with fluid; and though the lower end of the femur or the upper end of the tibia is replaced completely by a new growth, there is no enlargement of the bone. The same mistake may easily occur in the acute suppurative arthritis of infants, especially as rapidly-growing sarcomata, such as simulate abscesses, are often attended with a typically hectic temperature.

Chronic inflammation of bone, with the formation of a sequestrum (quiet necrosis), is most deceptive, especially when the shaft of one of the long bones is concerned. Even after spontaneous fracture has occurred it is sometimes impossible to make a diagnosis without free exploration.

A few instances have been recorded of pulsating tumors of bone without any sarcomatous growth (osteo-aneurysm); such, however, are very rare. True aneurysm may sometimes cause a certain amount of difficulty, but in nearly every

ne the position, the relation it bears to the artery, the fact that the sac can be mptied by pressure, or the history, settles the question at once.

**Treatment.**— 1. *Central Sarcomata.*—Excision may be practiced when the tructure of the part allows it, and the growth has not become diffused too widely. Thus, the upper end of the fibula may be completely removed, or part of the ulna; and the upper end of the humerus even has been treated in the same way, leaving a fairly useful limb. But all such cases must be very carefully watched, for fear of local recurrence.

Where this is not possible, amputation should be performed sufficiently far above the growth to make sure that the tissues are healthy, and if the bone is divided the cut surface of the medulla should be very carefully examined.

2. *Periosteal Sarcomata.*—For these, amputation is the only resource. If the growth is situated at the distal end of one of the long bones, and the disease is not of long standing, the operation may be performed through the shaft, at a sufficient distance above. Recurrence is very probable, but if the sawn section of the bone is healthy, it may not take place in the stump. When the disease is situated higher up, disarticulation should be practiced, except in the case of the hip. Amputation at this joint for periosteal sarcoma at or above the middle of the bone is practically hopeless.

Portions of the clavicle have been excised successfully for central sarcoma; but when the growth is periosteal, or when it has invaded neighboring structures, it must rest with the patient whether such an operation should be undertaken. Resection of the inferior angle of the scapula is not a serious or difficult matter, if it is done as soon as the nature of the tumor is recognized. The whole bone has been removed on some twenty occasions, with preservation of the arm; and more than once the whole of the upper extremity, with the scapula and part of the clavicle, has been taken away. Nearly all of these, however, have terminated fatally within the twelvemonth, from secondary deposits in the lungs.

## Cysts.

Hydatid cysts are occasionally found in bones; and chronic abscesses sometimes leave behind them smooth-walled spaces with clear contents; but unless they lead to great dilatation or to spontaneous fracture, they are not likely to be diagnosed.

Cysts, due to softening, degeneration, or hemorrhage, are very common in connection with sarcomata, especially central ones; but, except some occurring in the jaws, which, owing to their special character, are described by themselves, other forms are almost unknown.

## Carcinoma.

It is doubtful whether, in the absence of epithelial elements, primary carcinoma of bone can occur. Secondary deposits, however, are not unfrequent; cancer of the vertebræ, for example, may occur in scirrhus of the breast; and especially in the leg, over the subcutaneous surface of the tibia, epithelioma may gradually extend down into the substance of the bone.

## SECTION IV.—INJURIES OF JOINTS.

These, like injuries of bones, are divided into two classes. In the one there is no external wound; the skin is unbroken; the tissue changes that follow are rarely more than is required for repair, and inflammation is rarely severe unless there is some additional irritant, such as gout or scrofula, to keep it up. In the other the interior of the joint is filled with fluid and exposed to the air; decomposition may set in at any moment; and if it does, it is certain to cause an attack of inflammation, which is very likely to end in the destruction of the joint or place life itself in danger.

### Wounds of Joints.

Punctures and clean incised wounds are caused by stabs and cuts; lacerated ones are usually associated with compound fractures or gun-shot injuries; but they may be produced by any crushing or tearing force, and may be of any extent, from a puncture, the very existence of which is doubtful, to a rent which lays open the joint from side to side. In many instances the diagnosis is clear at the first glance; the interior of the joint can be seen; or there is an escape of synovia, recognized, even when mixed with blood, by its peculiar glutinous feel; or the joint in a very few moments becomes distended with fluid. But in a few it is a matter of some difficulty, either from the nature and direction of the wound, or from the presence of neighboring spaces, such as bursæ, tendon sheaths and cysts, which contain the same kind of fluid, and which sometimes do, and sometimes do not, communicate with the central cavity. If there is the least ground for suspicion, the case must be treated with exactly the same precautions as if the joint were really opened; and no attempt should ever be made to explore the wound with the probe or the finger merely for the purpose of making certain. This, of course, does not apply to any case in which the wound is dirty, or inflicted with a dirty instrument, or in which there is the least probability of such a thing; thorough exploration, then, is essential.

**Pathological Changes.** — These are the same as those that follow other injuries; the danger arises from the size and complexity of the cavity, its extent of absorbing surface, and the difficulty of draining it effectually. Suppuration rarely occurs in small joints, and extensive wounds often heal with the least disturbance, because the risk of decomposing material being confined under high tension is so much less.

Large vessels are not often divided, but the small ones bleed profusely, and often before their orifices are closed the synovial cavity and the loose spaces around are filled with blood. Then the edges of the wound become red and swollen, the vessels dilate, lymph pours out through their walls, the perisynovial tissues become infiltrated and gelatinous, and the cavity grows fuller and fuller. Soon the irritation spreads to the lining of the sac, the endothelium falls away, the surface loses its polish, the folds and fringes become hyperæmic and swollen, small extravasations take place here and there, especially along the line of attachment of the capsule, and the joint becomes distended with a turbid, blood-stained mixture of synovia and lymph.

The subsequent course depends upon the kind and the persistence of the irritant. If there is no tension or decomposition, if the only injury is that which was inflicted at the moment of the accident and no other is added, the hyperæmia soon begins to subside, the quantity of fluid diminishes, the swelling of the cellular tissue disappears, the cells on the surface of the synovial membrane gradually resume their normal character, the edges of the wound cohere together, and the

becomes delirious. When rigors, or what are known as starting-pains, make th appearance, the prognosis is even more grave. The former may mean the on of suppuration or the beginning of pyæmia; the latter points to necrosis a destruction of the cartilages. Later, if the patient does not die from septic a sorption, the fever alters its character, and as granulations are thrown out, assum the hectic type, fresh abscesses, each causing a new outbreak, forming every n and then in the cellular tissue around. Finally, if the patient is not attacked b pyæmia or other complications, and does not sink from exhaustion, the constit tional disturbance gradually subsides as the wound becomes smaller, and the lim is left stiffened, wasted, and covered with scars.

**Treatment.**—Compound (open) fractures into joints, compound (open dislocations, and wounds of joints accompanied by injury to important structu near, will be dealt with by themselves. The age and constitution of the patient, th size and importance of the joint, whether it is in the upper or the lower limb, an the extent of the injury sustained by the soft parts and the bones respectively, ar the chief factors in determining what is to be done. The choice lies in each ca between preservation, excision, and amputation.

In the case of a wound the first thing is to prevent infection. A simple incision, such as that inflicted by a surgeon for the removal of a foreign body, should be closed at once. If it is large a catgut suture may be inserted; if small, the edges may be brought together and sealed with collodion, or covered with iodoform, or closed with lint dipped in Friar's balsam. A lacerated or dirty wound, on the other hand, or one the condition of which is even suspicious, must be thoroughly and perfectly cleansed. Whether the joint should be washed out or not, depends upon the character of the injury and the length of time it has been inflicted; but if there is any doubt it should certainly be done, additional openings being made if the cavity is a large one. In the case of the ankle, wrist, and elbow, it is an excellent plan to immerse the limb bodily in a corrosive sublimate bath for an hour each day, syringing the joint out thoroughly through a piece of rubber tubing inserted into the wound. I have on several occasions treated compound fractures into the wrist-joint, and they perhaps are the worst of the three, in this manner with excellent results. If it is the knee, this is hardly practicable, and infection must be prevented in other ways. Washing out the joint, even with the most active antiseptic, is rarely enough: it is very difficult to make it penetrate efficiently into all the recesses, especially in the case of a person who is somewhat advanced in life: in children it may answer, as the shape of the sac is more simple. Constant irrigation is more likely to succeed, especially if commenced at once: the products of decomposition can hardly collect then; and Treves has shown that if it is thoroughly carried out, and kept up night and day, even with simple water, a knee joint that has already begun to suppurate may recover with almost perfect mobility.

It is equally important to prevent tension and to secure perfect rest. A lacerated or contused wound should be left partially open and covered with a small piece of non-adhesive dressing, so that the exudation can escape at once; or if the synovial lining is very complex and ill-adapted for drainage, additional openings should be made, and tubes inserted into every pocket. When the knee-joint is concerned, the simplest way is to push a pair of dressing-forceps down through the wound, until it projects in the popliteal space, when a small incision may be made over the end, the tube grasped and drawn back again. Then the whole joint should be covered over with an abundance of wood-wool or some other thoroughly absorbent dressing.

The limb must be placed upon a splint in the most comfortable position (always provided it is a suitable one) and fixed securely; it should be raised if possible, well bandaged, and kept cool by means of an ice-bag or Leiter's coils. The patient must be placed on low diet, the bowels well opened, and sleep and quiet ensured by opium or chloral.

The temperature is the best guide to the subsequent treatment. If there is

ly a slight rise and the pain about the joint is not severe, the wound should not touched (unless drainage-tubes require to be taken away) until it is sound, the t meantime being enveloped in cotton-wool and well bandaged to prevent any tention of the capsule. If, however, the temperature rises more than one or o degrees, if the joint becomes distended and painful, particularly if it begins throb, the condition is much more critical. Cold and compression with layers cotton-wool may still be tried; leeches placed all round the joint; an ice-bag id upon the main artery of the limb (the femoral has been tied for acute sup- uration in the knee joint); or even the joint aspirated to reduce the tension; but the skin is boggy and œdematous, and if the swelling is diffuse, no longer nfined to the synovial sac, it is very doubtful whether suppuration can be pre- nted. If there is not speedy improvement, the joint must be laid open freely both sides (small incisions are worse than useless) and irrigated so thoroughly at retention of decomposing material is impossible. Then the limb must be xed to a splint in such a position that if ankylosis does occur, it may still be of ome service. Sometimes even after this the articulation recovers, especially in children, with a surprising degree of mobility. More often the severity of the inflammation subsides; granulations spring up; the amount of pus diminishes; organization sets in; and fibrous or bony ankylosis results. Occasionally abscesses continue to make their appearance along the limb (under the quadriceps in the case of the knee), and either the patient sinks under the prolonged suppuration or amputation is performed.

## SUBCUTANEOUS INJURIES.

### *Sprains and Contusions.*

Under this heading are included almost all injuries of joints that are not attended by permanent displacement of the articular surfaces. There may be merely a slight effusion into the capsule of a joint with a little stretching of some of the fibres; or the synovial sac may be filled with blood, the ligaments torn or wrenched off the bone, the muscles lacerated, the tendons displaced from their grooves, and the tissues torn and crushed as severely as if it were a dislocation. In many cases the sole difference between a sprain and a dislocation is that, in the one, the bones, which are wrenched asunder at the time of the accident, resume their normal relation as soon as the force is spent; in the other, they either remain fixed where they are or slip a little further aside.

Contusions are the result of direct violence, such as blows and kicks, and may be serious from the extent of the bruising or from the tension set up by the blood that pours into the cavity of the joint. Sprains, on the other hand, are due to violent and sudden twists, wrenching the joint when the muscles are either tired out or are caught unawares; probably, without this, they would very rarely occur. Astley Cooper said of dislocations that it was only possible for them to take place when the muscles were unprepared for resistance, and the same is nearly as true of sprains.

The *amount of injury* is very variable. In some there is only a spot or two of extravasated blood, just at the attached margin of the capsule; in others the joint, and the loose cellular tissue that extends along the bone and under the skin, are filled with it. Sometimes it is uncertain whether there is a rent or not; or the strongest ligaments in the body, such as the internal lateral ligament of the knee or ankle, may be torn in two. Nearly always when this happens they drag away with them a thin scale from off the bone. In severe cases the muscles always suffer, and sometimes they are extensively lacerated, possibly in the sudden spasmodic effort at recovery; the tendon sheaths are bruised and filled with blood; the nerves are stretched and torn; and even the bones show at times deep ecchymoses in their cancellous substance.

The pain at the moment is intense and of a peculiar sickening character, so

that the patient may fall down fainting; later the part becomes numbed, with a dull aching sensation, due to the tension of the nerves. Swelling generally sets in at once, and the synovial cavity is distended to its utmost in the course of a few moments; but sometimes, when it is due rather to inflammatory exudation, it is more gradual, and does not attain its maximum for twelve or even twenty-four hours. The skin is exceedingly tender, especially over the spot where the ligaments have given way; the least attempt at movement is looked upon with dread; and discoloration soon begins to make its appearance. In the case of a sprained ankle, if there are many small varicose veins round the joint, the ecchymosis may reach as far as the knee in a very short time.

Recovery is often imperfect. Inflammation does not occur unless there is some other irritant as well, but very often the joint remains cold, stiff, and painful whenever an attempt is made to use it. This may be caused in various ways. Adhesions may have formed, binding tendons down to their sheaths, or even uniting two articular surfaces to each other; the capsule and the loose tissue around may have become dense and unyielding (especially on the inner side where it is soft and thrown into folds); the muscles may be matted together; or the synovial sac may remain distended; but in many instances nothing can be found. Movement is restricted and painful, at one spot in particular, but there is nothing out of place. There is a sense of weakness about the joint, so that it does not feel as if it could be trusted, or it becomes swollen whenever it is used, but there is no inflammation; the skin rather is unnaturally cold; it is smooth, glossy, and livid, showing that the circulation through it is imperfect; the tissues, in short, are starved, from prolonged inactivity; they are unable to work, because they never get a proper supply of blood; and the only remedy lies in encouraging the circulation as much as possible.

**Treatment.**—Slight sprains, when the tissues are stretched rather than torn, are treated most successfully by massage and bandaging; but it must be carried out carefully and thoroughly. The limb must be raised, the muscles relaxed, and all constricting garments removed. At first the movement must be exceedingly light, and directed so as to diminish the sensitiveness of the skin, commencing above the injured joint, where the swelling has not yet shown itself, and working gradually nearer to it. The direction must always be toward the trunk; the thumb, or the tips of the fingers, or the palm of the hand, may be used, according to the shape of the surface; and the tender spots must be left to the last. If this is properly carried out, the swelling begins to diminish in a few minutes, and, as the circulation improves, absorption becomes more rapid, and the tendency to start and the involuntary shrinking disappear. Then more attention may be paid to the spaces in which the extravasated blood has collected; the tips of the fingers or the thumb may be made to trace out the irregular intervals between the bony prominences, moving round and round in small circles upon the skin; and gradually firmer and firmer pressure may be used, as the superficial structures become accustomed to it. This must be kept up until the effusion has almost disappeared, and slight passive movements, of such a nature as not to exert any traction on the injured ligaments, are allowed without resistance. Then the joint must be covered with several layers of cotton-wool, and compressed as firmly as possible with a flannel or a domett bandage. Generally speaking, this has to be repeated for two or three days, but each time the sitting is shorter and less irksome.

In more severe injuries, where from the tenderness over certain spots it is clear that some of the ligaments have given way, the same plan may be tried; but naturally a longer time is necessary for repair. Heat and cold, if used with sufficient energy, are of excellent service as temporary remedies. They help to check the effusion by constricting the small vessels, but they do not assist absorption: and the sooner methodical compression is applied the better. Care, of course, must be taken that the pressure really falls upon the parts that need it—not, for example, in the ankle, on the heel and the malleoli. Passive motion should be commenced as soon as the effusion is absorbed, on the second or third day. Even

the ligaments are torn, the joints may be moved gently through a very wide nge, without throwing the least strain upon them. For this reason a fixed apratus, such as plaster-of-Paris, should never be employed in sprains.

## Dislocations.

A dislocation is a sudden displacement of one of the bones of a joint from ts normal position. Gradual displacements, which result either from disease pathological) or from malformation (congenital), are better dealt with by themselves.

Dislocations are said to be *complete* when the articular surfaces are entirely separated from each other, *incomplete* when they are still to a certain extent in contact, as usually happens, for example, in the case of the knee. They are *simple* if the skin is unbroken, *compound* (*open*) if there is a wound exposing the interior of the joint; and the distal segment of a limb is always described as being displaced from the proximal.

**Causes.**—These are either predisposing or immediate.

1. *Predisposing.*—Dislocations are met with at all times of life, from birth to old age, but with very different degrees of frequency. With the exception of the elbow-joint, they are much more common in adult life, because then the bones are at their strongest, and naturally they are more often met with among men than among women. But, independently of this, there is a certain class of persons in whom they are peculiarly liable to occur. The muscles are poorly developed, the bony prominences feebly marked, and the ligaments loose and yielding, so that the slightest force, if the muscles are caught unawares, is enough to cause displacement. Fortunately in many of these the capsule is not torn and the injury is really only a *subluxation*, but occasionally it gives way under the strain and the head of the bone is forced through the rent.

Certain joints are especially liable to dislocation. In many instances this may be explained by their situation or construction. The shoulder, for example, which depends for its security mainly on the muscles that surround it, not on the shape of its articular surfaces or on the strength of the ligaments, is dislocated more frequently than all the rest of the joints together. In children, again, dislocation of the elbow is particularly common, owing to the small size and smooth, rounded surface of the coronoid, which does not offer so much resistance as the sharply marked process of adult life. In other instances the tendency is acquired; a shoulder-joint that has once been dislocated is more likely to be dislocated a second time; and if this happens often, the joint becomes so insecure that the bone slips in and out of the socket whenever the arm is raised from the side.

2. *Immediate.*—These are muscular action and external violence.

(1) *Muscular Action.*—In some instances, notably the lower jaw and the patella, this acts entirely by itself; in most, however, it is only of secondary importance, fixing the segments of the joint and rendering other articulations rigid, so that force is transmitted unbroken along the limb; and in dislocations by direct violence it plays no part at all. On the other hand, it is almost entirely responsible for what is known as *consecutive displacement*, that is, the alteration in the position of the dislocated bone after it has been driven through the capsule.

(2) *External Violence.*—This may be either *direct* or *indirect*. The former is not common, but it occasionally happens that the head of the humerus is driven directly through the capsule of the joint by a blow upon the shoulder; or, when the body is much flexed, the head of the femur forced out from the acetabulum on to the dorsum.

In dislocations by indirect violence the force is applied at some distance from the articulation, either to the same bone, or, as it falls upon the hand, to the other end of the limb. The neck of the bone is fixed and acts as a fulcrum, and the head, which represent the short arm of the lever, is tilted out from its socket and

forced against the capsule until it is driven through it. The spasmodic contr tion of the muscles and the weight of the part drag it still further aside.

**Pathology.**—The immediate effects of a dislocation are more extensive th would be expected from the appearance of the part and from the ease with whi repair is carried out when the skin is unbroken. Generally speaking, the tissues o one side of a limb are strained and rent, those on the other crushed and bruis by the pressure of the displaced bone. Ecchymosis, sometimes making its appea ance a long way off, and perhaps days after the injury, is always a prominent fe ture. The capsule is usually torn at its weakest spot, sometimes it is stripped o the bone, and occasionally it drags away with it portions of the articular margi The ligaments suffer in the same way, except the stronger ones, such as the ili femoral band at the hip, and the interosseous one between the tibia and fibula i their lower extremity; these either resist successfully, or only give way after th bones are broken. The muscles are always more or less crushed and bruised; i many instances they are extensively torn, unless, as sometimes happens, they wren away with them the process of bone to which they are attached. Arteries an veins share the same fate, but though they are not unfrequently compressed an bruised, so that the circulation through the limb is interfered with and even inte rupted altogether, the larger ones are rarely torn across in recent dislocation unless the violence is extreme. Nerves escape even better: they are so tou that they rarely give way, but if they are compressed there may be most inten pain, and if it is kept up for any length of time permanent loss of power m follow.

The bones are frequently broken; sometimes, as already mentioned, merely process is torn off; sometimes, as in the case of the fibula, when the ankle is di located, the shaft gives way, perhaps at a distance from the seat of injury. Occ sionally other structures that lie near are injured too; the trachea, for exampl may be seriously compressed in dislocations of the clavicle, and the spinal cord the medulla may be crushed in displacement of the vertebræ.

As soon as reduction is accomplished these effects begin to pass away; th blood becomes absorbed, the effusion into the synovial sac and the spaces near disappear, and the lymph thrown out by the injured structures gradually becom organized. In some instances, where the capsule is very extensively torn, the rer is never thoroughly repaired, and the joint remains weak and untrustworthy. I others an excessive amount of lymph is thrown out; for want of properly regulate passive motion, adhesions form between adjacent parts, and the joint becomes sti and more or less crippled and painful. The same thing may happen from injury t the neighboring muscles. Occasionally inflammation sets in—suppurative arthriti very rarely, so long as the skin is unbroken; but rheumatoid arthritis, or gout, c strumous disease, according to the particular diathesis, not uncommonly.

If the dislocation is not reduced the head of the bone and the surroundin structures mutually adapt themselves to each other. The old cavity gradually be comes contracted and shallow; in many cases the outline becomes angular from th pressure of the displaced head resting on one of its borders; the cartilage at th bottom grows thinner and thinner, and either disappears altogether, or is replace by fibrous tissue which fuses with the shrunken and collapsed remains of the cap sule; and, at length, though some semblance of its original character is alway preserved, the socket becomes so altered that even if the head of the bone wer replaced it could no longer play its proper part. How soon these changes tak place depends mainly upon the age of the patient and the presence or absence that kind of inflammation which so often complicates joint injuries. On the on hand, the glenoid fossa has been found so altered within thirteen weeks of the acc dent that reduction could not have been effected; on the other, the acetabulu has been shown to be to all intents and purposes intact after as many years.

The changes in the displaced bone depend chiefly upon the character of t bed upon which it rests and the extent to which the limb is exercised. If t articular surface is imbedded in muscles, or lies upon a soft mass of connecti

issue, the cartilage slowly becomes fibroid and disappears, the ends of the bones aste away, and lose their characteristic shape, and adhesions form between them nd the structures around. Where, on the other hand, it is directly in contact ith the periosteum, as in subcoracoid dislocation of the humerus, the surfaces ear each other away and become moulded together in such a fashion that the iginal outline can hardly be traced. In most instances the cartilage disap-ears and the articular lamella beneath becomes hard and eburnated, as in rheu-natoid arthritis (Fig. 203); sometimes it becomes fibrous, and a dense layer of simi-ar material forms on the opposing surface, so that movement is smooth and free. In time, if the part is sufficiently used, a new socket is developed, partly worn out by ab-sorption, partly built up by the deposit round the margin from the irritated periosteum; and the lymph thrown out by the surround-ing tissues becomes modeled into a capsule, lined with a membrane like that found in adventitious bursæ, and filled with a similar kind of fluid (Figs. 204 and 205). Occa-sionally this is carried to such an extent that the joint becomes nearly as useful as it was before; but as a rule, hinge joints do not succeed so well as ball-and-socket ones.

FIG. 203.—Old Subcoracoid Luxation of Humerus. The new cavity is for the most part eburnated; around is a new capsule of fibrous tissue, while some of the old is still left as a fringe on the edge of the glenoid fossa.

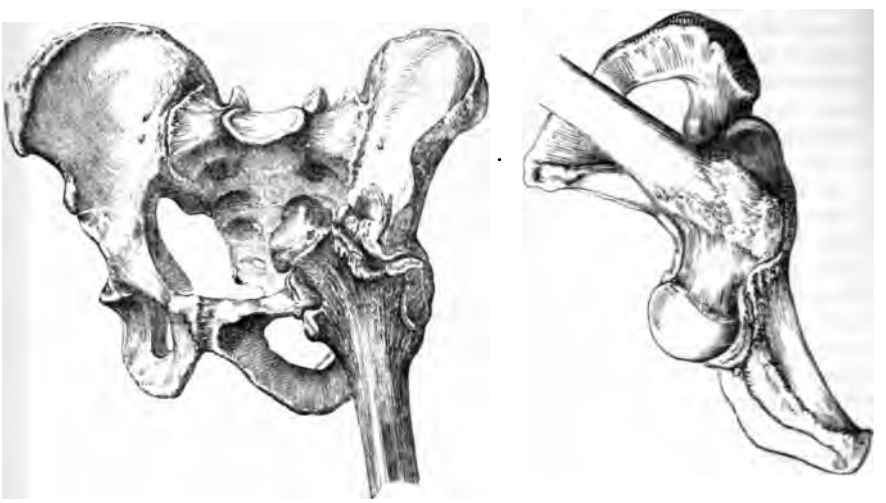
All the structures that lie near are more or less affected; the old capsule shrinks and contracts or becomes adherent to the car-tilage; the muscles waste from disuse and become fatty; the bone is hollowed out in the interior; and the tissues are matted together by bands of organized lymph. Sometimes the displaced bone is firmly fixed; sometimes it is so movable that it becomes a grave source of inconvenience. Occasion-ally it causes very serious consequences by pressing upon or becoming adherent to im-portant structures, such as nerves and blood-vessels. In all probability this is the reason why rupture of the axillary artery occurs so frequently in reducing old dis-locations of the humerus. The vessel is bound down to the head of the bone by adhesions, so that the strain falls directly upon it as soon as any traction is made upon the limb.

**Symptoms and Diagnosis.**—The only certain sign of a dislocation is the udden disappearance of the articular end of a bone from its normal situation, or s sudden appearance somewhere else. The account of the accident, though it ould always be carefully enquired into, is only of use as confirmation, and the ain depends mainly upon accidental circumstances. In most instances it is vere and long-continued, but when the dislocation has already occurred several mes it may be comparatively slight. Only in such cases as when the head of the merus presses upon the brachial plexus and causes intense neuralgia down the m, can it be looked upon as a diagnostic sign.

The first thing, therefore, is to compare the injured part with the corre-onding joint on the opposite side of the body. Sometimes the alteration in tline is conspicuous at the first glance, as in the sterno-clavicular articulation; r, as in dislocations of the hip, the position of the limb is enough to prove, not nly that the head of the bone has been forced out of its socket, but that it has een driven in one definite direction. If inspection fails, there may be some narked alteration in the length of the limb; or local measurements, especially in

such joints as the elbow, where the bony prominences are close beneath the skin, may supply the necessary evidence. If the diagnosis is still uncertain, deep pressure may reveal the altered position of the bones; natural prominences may have disappeared, or some depression may be filled up. Finally, before an attempt is made to move the part, valuable information may sometimes be obtained from other evidence of local pressure; the arm, for example, may be œdematous, from the head of the humerus resting upon the axillary vein, or the pulse at the wrist may be absent, from compression of the artery.

Inspection, measurement, and palpation may prove the existence of a dislocation; manipulation only can determine the particular variety and exclude all other injuries. Owing to the pain it causes, it should always be postponed to the last; and, particularly in the case of the hip and elbow, it is often necessary to administer an anæsthetic; the strength and the size of the muscles in the one, and the amount of swelling in the other, render it a matter of very great difficulty without. Voluntary movements are always restricted; in many instances, as in dislocations of the lower jaw, they are altogether impossible; passive movements are more variable; sometimes, when the soft parts are very extensively torn, they are unnat-



FIGS. 204 and 205.—New Sockets in Old Pubic and Subspinous Dislocations of Hip.

urally free, especially when the patient is under an anæsthetic; but nearly always they are restricted in at least one direction, either by the locking of the bones or by the tightening up of ligaments that have not given way.

The diagnosis has to be made from severe sprains, fractures in the neighborhood of a joint, and the separation of epiphyses. The chief features are the absence of crepitus, the character of the deformity, the fact that when it has once been rectified it does not return, and the immobility of the part, both as regards active and passive movement; but not one of these by itself can be regarded as sufficient. Crepitus is absent in many fractures and present in many dislocations, because there is a fracture combined with them; moreover, false crepitus, due to the displaced bone rubbing over tendons or pressing on bursæ filled with extravasated blood, is sometimes very difficult to distinguish from real. Deformity, too, may return at once, unless steps are taken to prevent it (as in dislocations of the ankle), and immobility, passive as well as active, is not by any means a sure guide. In each case it is absolutely necessary to weigh the whole of the evidence before coming to a positive decision.

A peculiar condition is occasionally met with in ball-and-socket joints (espe-

ly the shoulder), which, though not a dislocation in the strict sense of the term, resembles it in many respects. The head of the bone and the socket are both act, but they are not in apposition. The capsule is stretched; the articular faces are separated; there is complete loss of power; the position of the limb that of a real dislocation, but there is undue mobility. In the case of the merus there is generally paralysis of the muscles, passing from the trunk to the arm, d the head of the bone can be replaced at once by raising the elbow; in other nts it seems to be the result of chronic distention of the capsule: the fluid in- uates itself between the articular surfaces, and the fibres become softened and etched until they can no longer hold the bones in position. It cannot be called dislocation, because the head of the bone still lies within the capsule; but neither n it be compared with those cases in which, as a result of rheumatoid arthritis or rumous inflammation, the cartilages are eroded, the bones exposed, and the cap- le completely destroyed.

**Treatment.**—Dislocations should in all cases be reduced as soon as possible. he obstacles are of two kinds. One is mechanical; the head of the bone, for ample, no longer corresponds to the rent in the capsule; or it is caught by some gament or tendon, or locked against some other bone. The other is the contrac- ion of neighboring muscles. Immediately after the accident they are relaxed and ffer but slight resistance. In a short time they begin to contract and drag the islocated bone further and further away. Soon they become absolutely rigid, and t length they undergo a kind of fibroid degeneration; a great deal of their exten- ibility is lost, and they tear sooner than stretch. In recent dislocations this source f difficulty disappears entirely under an anæsthetic; in old ones it is added to the est.

There are two methods of effecting reduction, manipulation and extension. n the former, which is almost always used for ball-and-socket joints, the muscles re relaxed, either by placing the patient under an anæsthetic or by moving the imb in suitable directions; the head of the bone is disentangled from the structures hat hold it, and brought back along the route it has taken until it is opposite the ent in the capsule; then it is either lifted over the margin of the socket or tilted n by using the untorn portion of the capsule as a fulcrum and making the limb he long arm of the lever. In the latter the muscles are stretched until they either ield or tear, all obstacles are broken down or pushed aside by main strength, until he head of the bone is free and can be forced into position again.

Extension may be made with, or without, the aid of appliances, but in recent islocations it rarely happens that more than a jack-towel is required. The trunk r the proximal segment of the limb must be securely held for counter-extension. f it is the humerus, the knee or the foot may be placed in the axilla; or a well- added towel or leather belt passed round the arm and fixed to a hook or staple the opposite wall; but it is of great advantage to have an assistant who, besides elping to fix the scapula, can manipulate and disengage the head of the bone at e same time. In the case of the femur, if manipulation has failed and extension being tried, this is always one person's duty.

In recent dislocations, simple manual extension is generally sufficient, espe- ally if the muscles are relaxed by an anæsthetic; and the limb may be grasped the most convenient situation—the wrist, for example, in dislocations of the merus. If more than this is required, a jack-towel may be made into a clove- ch and fastened round the limb; but the skin must be perfectly protected by ans of a wet bandage, and extension must be made from the lower end of the placed bone without an intervening joint. If the limb is grasped with the hands, d the loop of the towel is passed over the shoulder of the operator, so that he n bring into play the muscles of his back, sufficient power may be obtained to ercome the resistance of any joint but the hip.

If the dislocation has already lasted some length of time, so that the muscles ve degenerated and the lymph has become organized, mechanical contrivances, ch as multiplying pulleys, may be required. The adhesions are first broken

down by manipulation and rotation; then the limb is carefully bandaged with a w roller to prevent slipping and to protect the skin; counter-extension arranged s as to avoid bruising, and to leave the part accessible; and the leather collar t which the cord of the pulley is attached buckled round the lower end of the di placed bone. An anæsthetic is indispensable. The other end of the pulleys is the made secure, and the rope tightened very gradually and quietly, avoiding anythi like a sudden jerk, and making extension in the axis of the limb. The amount o force must be regulated by the case: the operator must keep his hands upon th head of the bone, assisting it as far as he can in the right direction by manipula tion and rotation, and watching carefully the progress that it makes and the tension upon the skin. Very serious injuries have before now been inflicted in cases of this kind, and sometimes important structures have been torn across, even when the amount of force used was quite insignificant, probably owing to the tissues being bound together by adhesions, or softened and weakened by degeneration.

When pulleys are not available, a very efficient substitute may be manufactured out of a simple piece of rope doubled once or twice upon itself. By placing a ruler in the middle and twisting it up, any required degree of traction may be obtained, slowly and evenly. No estimate, it is true, can be formed as to the actual amount of force employed; but it is more than doubtful whether such is really of any use; each case must be decided on its own merits.

As soon as the head of the bone is brought down, an attempt must be made to carry it in the direction of the socket. If it is the humerus, the arm is drawn across the chest, making use of the surgical neck as a fulcrum, or it is abducted as far as it can go.; or, while the arm is fixed, the trunk is swayed slowly from side to side. If the femur, a broad band is looped round the thigh to lift the bone upward, or outward, according to the direction of the displacement. In the case of the lower jaw, again, firm pressure is made in a backward direction upon the coronoid processes. In short, in each dislocation the method of manipulation, when once the head of the bone has been forced down, must be guided by the structure of the joint, the direction of the misplacement, and the character of the obstacles that stand in the way.

After a certain period, varying for each joint, reduction becomes impossible. Even if it could be effected, it is more than doubtful whether the use of the part would in any way be improved, owing to the extensive changes that take place about the articular ends. In such cases all that can be done is to break down the adhesions as thoroughly as possible, and by means of massage, friction, galvanism, and passive motion, improve the nutrition and freedom of the parts as far as may be.

In recent dislocations, when the patient is not under the influence of an anæsthetic, as soon as the head of the bone is brought opposite to the rent, it is pulled into the socket, with a sudden, sometimes almost audible, snap. In old ones, however, or when the muscles are relaxed, and in paralyzed limbs, replacement is gradual, and may even be imperceptible, except for the restoration of the full range of movement, and a certain amount of alteration in shape.

The treatment of a dislocation, after it has been reduced, does not differ from that of a severe sprain: the joint must be secured, so that there is no danger of a recurrence; kept perfectly quiet, and either bandaged or covered with some evaporating lotion, or with Leiter's coils. Inflammation rarely follows, probably because the capsule is extensively torn, and intra-articular tension is impossible; but, for all that, every precaution should be taken to prevent its occurrence.

The length of time the joint should be kept at rest depends more upon its kind and construction than on the injury that has been inflicted. There are dangers on either side. On the one hand, if the part is kept at rest too long, adhesions may form between contiguous surfaces, or the capsules become hard and rigid. On the other, if movement is allowed too soon, there is always the possibility of the r in the capsules never being repaired, or, worse still, of inflammation setting in. T question turns mainly upon the kind of movement. Passive

e, and, if carried out under proper supervision, may be commenced in the first ek; it stretches out the folds of the capsule, prevents the muscles and ligaments coming shortened, and checks the formation of adhesions, without endangering e prospect of union or giving the faintest reason for inflammation. Active move-ent, on the other hand, because it cannot be so well controlled, must be postponed til passive motion is free from pain, and until all risk of recurrence has disap-ared. In the hip and elbow, where the security of the joint is dependent upon e shape of the articular surfaces, it may be allowed with certain precautions after e first few days; in the lower jaw, however, and still more in the shoulder, free ovement without restriction cannot be permitted for at least a month, and certain rticular actions are especially to be forbidden. A variable amount of stiffness is ways present after a dislocation, and the muscles atrophy to some degree, particu-rly the extensors; but this soon disappears. Massage and galvanism are of very reat service if it shows the least tendency to persist. It must not, however, be rgotten that a rapidly progressive form of osteo-arthritis is not an uncommon omplication of joint injuries, especially in those who are gouty or rheumatic, and hat muscular wasting is one of its earliest signs.

*Compound (open) dislocations*, in which, in addition to the displacements of the ones, the skin is torn or cut and the synovial cavity of the joint exposed, are ex-eedingly serious, even when they are not complicated by the addition of fractures r other injuries. The danger is the occurrence of suppurative arthritis. If this reaks out, the joint rarely recovers without some degree of ankylosis; often the avity is entirely obliterated and the articular surfaces are united together by dense ibrous tissue or by bone. Even this result, however, cannot always be obtained. If suppuration once develops it is impossible to say when or where it will stop, nd the risk, as regards life as well as limb, increases with the size and complexity f the synovial membrane. Abscesses may form in the tissues near; the pus may pread in the tendon sheaths, or in the loose tissue around them half-way along limb; erysipelas, cellulitis, or pyæmia may break out at any moment; the bones ay be eaten away on the surface or even perish completely; and at length, if the atient does not succumb from septic absorption, and if the limb does recover, t may be so stiff and œdematous as to be absolutely useless, or there may be such n amount of discharge that it has to be removed for fear of hectic or amyloid isease.

The treatment of open dislocations must be guided by the same considera-ions as that of open fractures into joints. The choice lies between an attempt o save the part, excision or amputation; and the decision must be determined in ach case partly by the age and constitution of the patient, partly by the situation f the joint and the extent of the injury. The first question is whether it is pos-ible to save the limb without running too great a risk, and whether, supposing this s successful, the limb is likely to be of any use afterward. In open dislocations f the knee joint there is rarely any hope unless the tissues at the back are quite ntact; but in other joints, especially in those of the upper extremity, it can often e managed, if only the vessels are unhurt and the skin not too much torn or ripped up. Nerves do not seem to be of so much consequence in this matter; ey are so tough that they rarely give way, and even if they do they may often e joined again by means of sutures.

Whether the joint should be excised or not depends upon the condition of the ds of the bones. If they are comminuted, and the soft parts not seriously injured, is may be done with great success, especially in the case of the shoulder and ow; but it must always be remembered that primary excision is not to be com-red, either in its course or its results, with the same operation when performed r disease. The smaller joints, those in the fingers, for example, sometimes suc-ed very well.

If it is decided to try and save the joint, the protruding bone and the surround-in must first be thoroughly cleansed with some antiseptic; fragments that are ed or ground-in with dirt to live, removed; and reduction effected

as soon as possible. Generally there is no difficulty in this, owing to the ext the laceration; but sometimes the head of the bone is so tightly embraced by skin that the opening has to be carefully enlarged.

Then the cavity of the joint must be washed out again and again, and freely open, so that there may be thorough drainage. The most efficient met of carrying this out is either to immerse the part bodily for an hour each day bath of corrosive sublimate or carbolic, with the wounds widely open, or to continuous irrigation with water as already described in speaking of penetr wounds. Merely passing a drainage-tube through the synovial cavity is of little no service, and small incisions are worse than useless; the discharge must be th oughly removed. The limb may then be placed upon a splint, well bandag raised and kept at perfect rest in the position that will ultimately be most use An ice-bag laid upon the joint, or over the course of the main artery of the lim is of some assistance in controlling the amount of blood flowing to the part; b care should be taken that the application is really continuous.

The further course must be guided by the temperature and the degree inflammation that ensues. Careful watch must be kept that the discharge cann collect anywhere. If suppuration sets in the freest possible incisions may still b tried; but unless it is checked at once the cartilages necrose, the synovial lini is destroyed, the cavity is filled with granulation tissue, and abscesses form every where in the cellular tissue around. At first the constitutional disturbance is exceedingly severe, especially in the case of the larger joints; gradually, as the tissu gain the upper hand, the fever begins to drop of a morning, and if no further complication sets in assumes the hectic type; and then again it may become a question whether the patient's strength is sufficient; or whether it may not be advisable to perform some secondary operation, excision, or even amputation.

Fractures and dislocations are not unfrequently combined, and occasionally, a fracture is present as a complication; the humerus, for example, is dislocated, and the surgical neck broken by the same force. When this occurs it has been recommended to allow the fracture to unite before attempting to reduce the dislocation, but if it is possible the head of the bone should be replaced at once. The patient should be placed under an anæsthetic, the fracture securely fixed between splints, and the displaced bone manipulated as far as it can be in the right direction. Extension may be tried if the fracture is at some distance, at the other end of a long bone, or even in the middle; but if the injury is near the joint it is rarely practicable. If this fails the only course left is either to lay the part open, and convert the fracture into a compound one communicating with a synovial cavity, or by passive motion to encourage as far as possible the formation of a false joint.

## Dislocations of the Lower Jaw.

Dislocation of the lower jaw may be unilateral or bilateral, but it can only take place in one direction, forward. As the mouth opens the condyle and the fibro-cartilage are brought forward together upon the eminentia articularis; the external lateral ligament, which normally runs downward and backward, becomes nearly vertical; the internal and posterior are stretched, and the coronoid process is lowered into a slanting direction. If at this moment the external pterygoid contracts, or if a slight blow is delivered in a downward direction upon the incisor teeth, the condyle slips forward on to the front of the eminence and is carried up into the temporal fossa by the combined action of the temporal, masseter, and internal pterygoid. The capsule appears to stretch rather than tear, though the tension on some of it must be very severe, and sometimes the temporal muscle is a little torn.

**Causes.**—Dislocation may be produced either by muscular action alone, by indirect violence, but neither of these is capable of effecting it unless the mouth is widely open. If it is the former of the two, the condyle is pull

ward; if the latter, the bone is converted into a lever, of which the oronoid process, fixed by the temporal muscle, is the fulcrum; the force is plied to the symphysis, and the condyle is driven forward. It often happens m yawning or shouting, but it may be used by blows with the fist, by forcing to the mouth anything that is too large, d even by such operations as the extrac- n of teeth and taking wax casts of the veolar arch. It is rare in children, because them the eminence hardly exists, and cause, owing to the shape of the jaw, the mporal muscle does not obtain such lever- ge; and it appears to be more common women than in men.

FIG. 206.—Dislocation of the Lower Jaw.

If both sides are dislocated the symp- oms are very characteristic. The patient pports the lower jaw with his hand, to revent further movement, the mouth is idely open, the chin protrudes, the saliva ribbles away, and speech is exceedingly ifficult. Labial consonants cannot be pro- ounced at all. In place of the natural rojection in front of the ear, caused by he condyle, there is a depression; in front f this, making it more distinct, the skin is aised, partly by the bone, partly by the regular contraction of the fibres of the masseter; and movement, except to a ery slight extent in a downward direction, is out of the question. The first ime the dislocation happens the pain is very severe, but in old recurring cases t may be so slight as not to cause any complaint. If the displacement is only n one side, the lower jaw appears to be pushed toward the other one; the face s much less distorted; and though the general symptoms are the same, they are ften so slight as to lie in some danger of being overlooked.

Subluxation or partial dislocation forward, is very common in young people, nd sometimes gives rise to much inconvenience, as it is liable to occur whenever he mouth is widely open. The jaw is caught, as it were, and held until the ondyle is forced back by pressing the chin upward; formal reduction is rarely ecessary.

**Treatment.**—The patient should be seated with the mouth wide open; the ead is thrown back and supported from behind, the thumbs (protected with a andkerchief or some lint so that they may not be bitten) are placed on the molar eeth as far back as possible, the fingers brought round under the chin, and pres- ure made downward and backward with the one, while the symphysis is raised y means of the others. By this the lower jaw is converted into a lever of the irst order, the thumbs form the fulcrum, and ought therefore to be placed as far ack as they can; the downward pressure helps to disengage the condyles, and as oon as they become free the muscles pull the jaw back with a sudden snap. Gen- rally the two sides slip back together; but in old dislocations, or if there is any ifficulty, an attempt may be made upon one first, only care must be taken not to isplace it again while the other is being reduced. Sometimes reduction is im- ded by the coronoid process becoming entangled in the fibres of the temporal uscle; and in one case, at least, it is certain that it caught against the malar ocess; but this can generally be obviated by depressing the chin somewhat ther before trying to raise it.

If this plan fails other measures must be adopted to obtain more power. dges of cork or wood may be placed between the molar teeth and the chin wn up by main force; in one case, four months old, Pollock made use of a

strap tourniquet, which was passed round the head, under the chin, and s screwed up. The angle may be depressed by resting one end of a flat pie wood about a foot long upon the molars, and pulling the other upward, the of the upper jaw serving as a fulcrum; or a stout pair of forceps may be i duced as far back as possible, and the blades separated from each other. D pressure backward upon the coronoid processes from the inside of the mou sometimes successful, even in dislocations of long standing.

A four-tailed bandage must be worn for a week or ten days after, and patient should be warned that yawning or opening the mouth wide for any o purpose is exceedingly likely to reproduce the displacement for months to co

If the dislocation is not reduced, the amount of movement gradually incre until the patient is able to close the lips and to open the mouth fairly wide, but teeth can never be brought properly into apposition with each other.

### Dislocation of the Clavicle.

The sternal end of the clavicle is rarely displaced, although the articular s faces are very little adapted to each other. The shoulder is so freely movable th no severe strain falls upon the joint, unless the force is applied to the clavicle directly, and the inter-articular fibro-cartilage, and the ligaments that hold the bones together, are so strong and secured so well by the muscles, that the clavicle, as a rule, gives way before the joint. The natural movements take place either on a vertical axis between the fibro-cartilage and the sternum, or on an antero-posterior one between the same structure and the clavicle. When they are carried too far the capsule gives way, and the articular end of the bone is forced through the rent, either forward, backward, or upward.

In spite of the backward direction of the articular facet on the sternum, and the hook-like projection on the posterior margin of the clavicle, dislocation forward is the most common of these. The sternal end of the bone is carried on to the front of the manubrium, and stands out beneath the skin; the clavicular portion of the sterno-mastoid is tense and rigid; the head is inclined downward and forward; the shoulder is approximated to the middle line, and all the movements of the arm, but particularly any attempt to bring the shoulders forward, are attended by severe pain.

Dislocation backward is equally plain, only in this case there is a well-marked depression by the side of the manubrium instead of an elevation, and the shoulder is brought forward, as well as toward the middle line. Sometimes the head of the bone presses upon the trachea or œsophagus, causing extreme dyspnœa or dysphagia, and in one instance coma is said to have ensued from pressure upon the innominate vein.

Dislocation upward is more rare, and might almost be regarded as a variety of the former, as the articular end is always carried backward as well to some extent, sometimes sufficiently far to press upon the trachea. It lies behind the sternal portion of the sterno-mastoid, between it and the sterno-hyoid, filling up the episternal notch; the shoulder is carried far inward toward the middle line, and the neck is bent, as much to relieve the respiration as to relax the muscles.

In all of these the rent in the capsule is very extensive: the rhomboid ligament either gives way, or the cartilage of the first rib is torn: the fibro-cartilage in the interior of the joint is separated from the clavicle, or more often from the sternum; and the muscles, especially the sterno-mastoid, are put upon the stretch, and sometimes torn.

**Causes.**—Dislocation of the sternal end of the clavicle may be produced either by direct or indirect violence. In the former case the force is applied to the inner end of the bone, as when a cart-wheel passes over the chest; the displacement must be either backward, or backward and upward; and often the surrounding structures, such as the ribs and sternum, are crushed as well

er, where the force acts either on the shoulder or on the outer end of the bone, displacement may take any direction, except downward. A blow, for example on the front of the shoulder, forcing it backward, causes the clavicle to rotate its centre, and throws the strain upon the anterior sterno-clavicular ligament, joint opening out in front. If the force continues, the head of the bone is displaced forward until the ligaments give way, and it is carried on to the front of manubrium. In a similar manner, a force applied from behind, or violent action on the arm from the front, causes the clavicle to rotate in the opposite direction, and tends to produce dislocation backward. But while the cause of these dislocations is fairly clear, the mechanism by which they are produced is not so easily understood. Owing to the convexity forward of the inner part of the clavicle, it is impossible for the first rib to act as the fulcrum of a lever; and these dislocations cannot be produced in the dead subject, without previous division of some of the ligaments. They cannot therefore be the result merely of traction or pressure applied to the outer end of the bone, regardless of everything else. The contraction of the surrounding muscles is of some assistance, and rigidity of the thorax is very likely essential (they have been produced on several occasions by pressure in crowds, and by wrestling), but probably the most important element is the position of the vertebral column at the moment of the receipt of the injury. In some cases of extreme spinal curvature, gradual displacement has resulted from this alone without the occurrence of any accident.

Partial dislocation, without tearing of the capsule, is common among young people of weak muscular development; and is often noticed for the first time after some sudden strain or unusual muscular exertion. The bone projects on the front of the articulation forward, or forward and upward, but slips back again into its position as soon as the weight of the limb is taken off. The chief inconvenience is the weakness of the arm and the sense of insecurity; sometimes this is so marked that the use of the limb is seriously impaired.

**Treatment.**—The method of reduction is the same for all of these. The patient is seated upon a low stool, with his back to the operator. The latter places his knee against the spine, between the scapulæ, and grasping the shoulders, draws them backward, the patient's elbows being kept in front of the mediolateral line. Generally the head of the bone slips in either at once or with a little manipulation; if it resist, a stout pad may be placed in the axilla, and the elbow be drawn into the side, so as to pry it out. The difficulty is after reduction has been effected; there is nothing to retain the bone in its proper position; the articular surfaces are almost flat; all the ligaments are torn; the whole weight of the arm rests upon it; and every movement, even that of respiration, affects it.

In the backward, or the backward and upward dislocation, Velpeau's plan is the best. The bone is held in position; the axilla carefully padded so as to square up as far as possible the conical shape of the thorax; the elbow brought forward to the middle line, and well raised by strips of plaster, and the hand fastened against the opposite shoulder. In the forward dislocation, which in this respect is the worst of the three, a double figure-of-eight succeeds better. A stout pad or a thickly covered splint is placed between the shoulders, and the bandage is carried round them alternately, to draw them back as far as possible. Astley Cooper recommended that well-padded straps should be carried round the axillæ, and fastened back by leather bands to a splint, fitting against the spine, and well secured round the body. In any case it is important to fix the scapulæ against the ribs; and where there is serious concern about the deformity, the best plan is to keep the patient in bed, in the supine position, as long as he can be induced to stand it. If the dislocation is forward, a well-fitting pad over the projection, firmly strapped down, is often of great assistance.

Whichever method is adopted, the arm must be kept rigidly fixed for at least three weeks; if plaster is not used, the bandages must be secured with starch or gum, as Velpeau recommends; after that the confinement may be relaxed to ...ut no movement should be allowed for at least as long again; and

...roperly made truss, must be worn until it ...
... instances it is impossible to retain the ...
... orward this is not so serious, though the ...
... soon forms, and the arm regains a ...
... movement; but when the bone lies wedged ...
... sternum and the trachea, and either cannot be ...
... om slipping back, it has been found necessary ...
... nner extremity.
... *Place the dislocated bone on the position which ...*
... *cate from the articular cavity, and then reduce ...*

... OF THE SCAPULA.

... ated from the clavicle in two directions, upward ...
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... coid ligaments, which form the main bond of ...

... a fall or a blow upon the shoulder delivered from ...
... the point of the acromion downward and for- ...
... however, is met with now and then in rapidly grow- ...
... eavy weights upon the arm. Probably in these ...
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... hardly be mistaken. The head is inclined to the ...
... trapezius stands out distinctly; the outer end of ...
... a great projection upon the acromion, and the ...
... There is tenderness on pressure over the cora- ...
... are painful and very limited, and raising it even ...
... impossible.
... location is very easy to reduce and very difficult ...
... is necessary is to draw the shoulder back, press the ...
... slips out from underneath at once; but as soon as ...
... placement appears again. Very often the bones can- ...
... a new joint is gradually developed in the upper sur- ...
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... er the acromial end of the clavicle and strapped firmly ...
... webbing band carried over it and under the point of ...
... the axilla must be well padded and the scapula fixed as ...
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... st be kept lying flat on the back in bed for a week or ...
... ixed perfectly; the weight of the limb is taken off; the ...
... clavicle can easily be prevented from riding up.

... OCATIONS OF THE HUMERUS.

... ocated more frequently than all the other joints in th ...
... to its anatomical construction; its security is de ...
... the muscles and tendons that surround it; the glenoid ...
... that it can afford no protection for the head; the cap- ...
... one part, is exceedingly loose and weak; the move- ...
... directions; and the length of the arm gives such enor- ...
... the head of the bone is driven against the capsule it ...

... always ind ... —a fall upon the elbow or the

outstretched hand; occasionally direct—a blow, for instance, upon the back of the shoulder while the arm is abducted; in a few rare instances, muscular action by itself, without outside assistance.

1. *Dislocation by Indirect Violence.*—This is always the result of abduction. As the arm is lifted away from the side, the great tuberosity comes into contact with the upper margin of the glenoid fossa and the surgical neck with the acromio-clavicular arch; if the scapula is fixed and the force continues, the head projects against the under and inner part of the capsule until it tears it across, leaving the strong upper part tensely stretched by the strain that falls upon it; then as soon as the force is expended the weight of the arm and the contraction of the muscles carry the head of the bone along the margin of the glenoid fossa, until it either reaches the base of the coracoid or is buried in the substance of the subscapularis. In the first part of the act, the great tuberosity or the surgical neck forms the fulcrum of the lever; as soon as the dislocation is effected, the upper untorn portion of the capsule (the coraco-humeral ligament included) becomes the fixed point, and the head of the bone glides upward as the hand sinks. In a few instances, owing to the head of the bone in some way being caught immediately after bursting through the capsule, this consecutive displacement does not take place, and the arm remains in the position of extreme abduction (*luxatio erecta*).

Complete abduction, however, is not absolutely necessary. If the arm is held only a moderate distance from the side, a blow upon the inner condyle of the humerus, or an outward pull upon the arm, may dislocate the head of the bone. One part of the humerus is fixed by the coraco-humeral ligament; another a little lower down, by the muscles, especially the deltoid; some point between the two serves as a fulcrum, and the force applied to the inner side of the elbow levers the head of the humerus out.

2. *In dislocations by muscular action*, which are much more rare, the mechanism is somewhat the same, only the force in this case is the momentum of the arm. When it is moderately abducted, the upper part of the shaft of the humerus is fixed between the abductors (the deltoid) and the adductors (the pectoralis major and the latissimus dorsi), so that a kind of fulcrum forms, upon which the arm swings. If at the moment this takes place the lower part of the arm is moving vigorously in the direction of abduction, the head of the bone is driven to the opposite side, against the front and inner part of the capsule, and may be forced through into the subscapular fossa.

3. *Dislocation from direct violence* is not very uncommon. It can easily be produced by a blow upon the shoulder when the arm is abducted and held in a horizontal position. The scapula yields a little, the head is driven against a weak part of the capsule, and the bone is dislocated either backward or forward, according to the position of the arm and the direction of the blow.

### *Varieties.*

With the exception of some of those that are produced by direct violence, all dislocations of the humerus are primarily downward into the axilla, but it is only in the rare cases of what is known as *luxatio erecta* that the bone retains that position. Nearly always it is carried, partly by the weight of the limb, partly by the contraction of the muscles, either in a forward or backward direction, upward along the margin of the glenoid fossa.

There are four well-marked varieties of this consecutive displacement: three forward—subglenoid, subcoracoid, and subclavicular; and one backward—subspinous. Besides these, minor varieties have been described—subacromial, for instance, and supra-coracoid; but they are very uncommon, and the latter at least cannot take place without the presence of fracture as well.

1. *Subcoracoid Dislocation.*—This is by far the most common; indeed, it is the only dislocation that is usually met with, the others are all exceptional. The rent in the capsule lies on the inner and lower border of the glenoid fossa, often

commencing at the opening for the bursa; the head of the humerus is p
between the bone and the subscapularis muscle up to the root of the coracoid,
the anatomical neck rests upon the anterior margin of the glenoid cavity;
muscle is bruised and stripped up from its attachment, the upper and back p
the capsule is strained across the glenoid cavity, the tendon of the biceps is l
out of the groove as far as the capsule will allow it, and the external rot
attached to the great tuberosity are stretched or torn. If, as sometimes happ
they give way completely or wrench the tuberosity away from the shaft, the b
is drawn more toward the middle line and is less rotated. Sometimes the axill
vessels and the brachial plexus are compressed, but this is not so common or
well marked as in the subglenoid form.

2. *Subglenoid Dislocation.*—In this, which is the next most frequent, the h
of the bone either escapes below the subscapularis, between it and the teres musc
or is driven through its substance and pulled up until it rests upon it opposite t
lower margin of the glenoid fossa. The rent in the capsule may be the same as
the subcoracoid variety, or the fibres may be torn away from the under and in
part of the humerus, but the difference does not appear to be material. The e
ternal rotators and the other muscles suffer to much the same extent, but the vess
and nerves are more likely to be compressed.

3. *Subclavicular Dislocation.*—This is the rarest of the four ordinary forms
in it the head of the bone is carried under the pectoral muscles to the inner side o
the coracoid process, so that it projects underneath the skin and can no longer b

FIG. 207.—Old Dislocation of Humerus, seen from above, showing the way in which the head of the bone and the glenoid edge mutually wear each other away and simulate a partial dislocation.

felt in the axilla. It can only be produced by extreme violence, rupturing the e
ternal rotators, or tearing the tuberosity away from the shaft; and the amount
damage inflicted on the surrounding structures is proportionately great.

4. *Subspinous Dislocation.*—Under this may be included all the forms of bac
ward displacement in which the head of the bone rests upon the dorsal surface
the scapula beneath the infraspinatus. The rent in the capsule must involve th
lower part, but probably in the majority of instances it extends nearly round th
whole, the upper part only being left strained across the glenoid cavity. Th
subscapularis may be merely stretched, or it may be torn away from the humerus

5. *In the supracoracoid* variety the head of the bone is driven upward betwee
the coracoid and acromion, fracturing one or other until it rests upon the coraco
acromial ligament and projects through the substance of the deltoid. Only thre
cases are on record.

Partial dislocations have often been described, but probably, in most i
stances, they have really been either old unreduced complete ones or the result
chronic rheumatoid arthritis. In the former case, when the head of the bone h
been resting for many years on the front margin of the glenoid cavity, it gradu
wears it away until it seems as if it were lying partly in the fossa itself, partly
the bone in front of it; in the latter, when the biceps tendon has been absorbed
torn across, the head of the bone is pulled upward and forward under t
acromio-clavicular arch, and forms there a new socket for itself, with a capsu

partly adapted from the old one, partly formed afresh (Fig. 244). Genuine cases, however, are occasionally met with; in one under my care, the patient, a tall overgrown girl of seventeen, was unable to place her hand at the back of her head, owing to the feeble development of the short muscles, the bone always slipped forward on to the anterior margin of the glenoid fossa, stretching the capsule more and more each time. In other cases, the same result is stated to have been due to the unusual development of the bursa under the subscapularis, and in one instance it was proved by dissection that the capsule had been torn in a way that would allow the head to be partially displaced.

*Recurrent Dislocations.*—A similar condition of things is sometimes met with after the reduction of an ordinary dislocation: the arm, when an attempt is made to use it, feels too insecure; if it is raised in the least, the head of the bone slips forward, and though it generally falls back again into the fossa as soon as it is lowered, sometimes it is caught and requires to be released by manipulation. This is probably caused by loss of power over the short external rotators, which are often damaged or torn in dislocations; but it may be due to part of the lip of the glenoid cavity having been pulled off by the capsule.

**Symptoms.**—The appearance presented by a patient with a dislocated shoulder is very characteristic; the head is bent toward the affected side; the forearm is supported by the other hand; the elbow is flexed owing to the tension on the biceps, and the shoulder has completely lost its rounded shape; the point of the acromion stands out beneath the skin; instead of the normal curve, the line falls almost vertically; the infra-clavicular fossa is obliterated; and sometimes the head of the bone projects through the substance of the muscles. The arm is abducted from the side, especially in the subglenoid variety; in the subcoracoid it may still almost touch, in spite of the convexity of the thorax: its axis does not run in the normal direction toward the glenoid fossa, but too much inward; the elbow, except in the subspinous form, has an inclination backward, though it does not pass the mid-lateral line of the body, and there is a general look of helplessness about the part. Sometimes the arm is swollen from pressure upon the axillary vein; or the radial pulse cannot be felt; or again there is intense pain down some of the branches of the brachial plexus.

If, in order to compare the two sides together more accurately, measurements are taken, the results vary according to the kind of dislocation: in the subglenoid, owing to the head of the bone lying below its normal level, there is lengthening with marked abduction (mainly due to the coraco-humeral band, but partly perhaps to the muscles); in the subcoracoid the abduction is less and there is no certain alteration in length; and in the subclavicular, in which the head of the bone is carried far inward, the arm points outward and is greatly shortened. One measurement, however, that is always increased is the vertical circumference of the shoulder, taken round the acromion and the axilla.

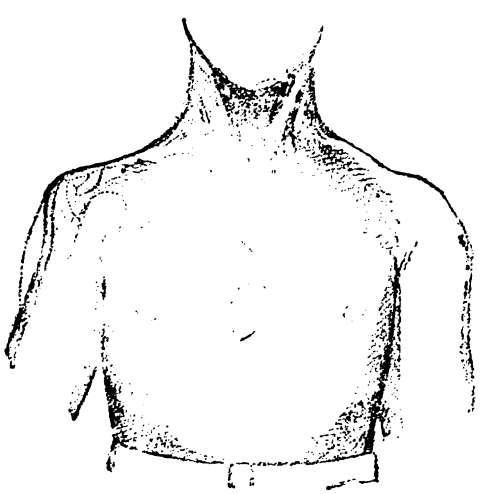


FIG. 208.—Subcoracoid Dislocation of Humerus.

These results are next to be confirmed by palpation. Under the acromion there is a great depression; the finger cannot be made to touch the glenoid fossa, owing to the deltoid and the external rotator muscles that cover it, but it seems to sink right in. In the subclavicular form the head of the humerus projects in such

a way as to strike the eye at once; in the subcoracoid it is not so promine this, but it always obliterates the natural hollow beneath the clavicle, an addition can easily be felt by pressing the fingers upward into the axilla. In subglenoid this is plainer still; the head of the bone lies lower down; there hollow between it and the coracoid; and the anterior fold of the axilla is prominent, owing to the drawing downward of the pectoralis major. I have seen two examples of dislocation backward, but in neither was there any diffic in making out the exact position of the head.

Finally, any doubt may be set at rest at once by manipulation. Volun movement is almost out of the question; passive movement, though more fre very painful, and definitely limited. The head of the bone rotates easily in new situation, though not so freely as when in the glenoid fossa; abduction certain extent is possible still; but adduction, so as to make the elbow touch side, especially when the fingers are laid upon the opposite shoulder, is absolu impossible in all forms of dislocation—the shape of the thorax is such that it

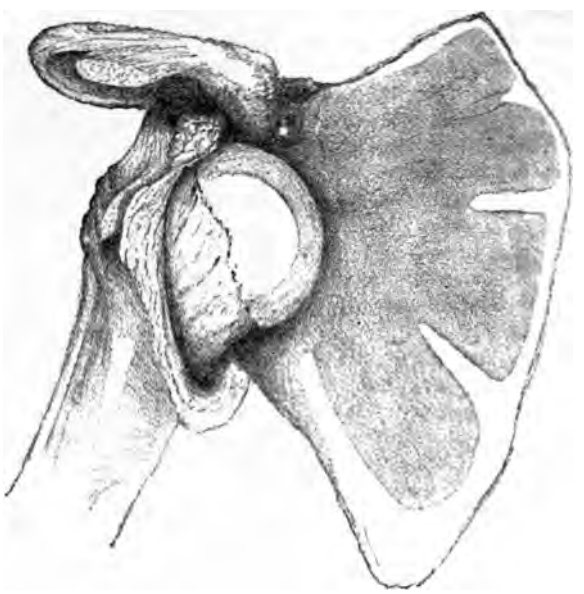


FIG. 209.—Subcoracoid Dislocation, with the Capsule Laid Open and Turned Back.

not be done. This and the vertical measurement round the axilla are almost clusive.

The diagnosis of dislocation has to be made from:—

1. Fracture of the neck of the scapula, in which the glenoid fossa an coracoid process are separated from the rest of the bone, carrying the arm them.

2. Fracture of the anatomical neck of the humerus.

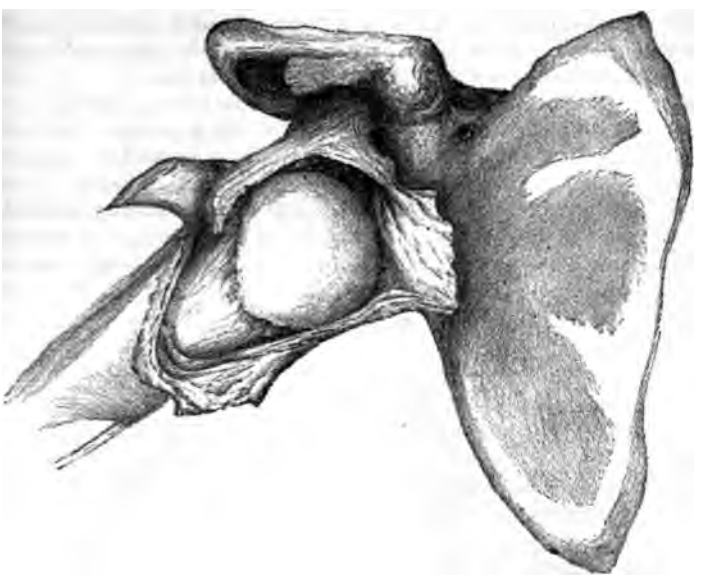
3. Fracture of the surgical neck.

4. Separation of the great tuberosity, in which the head of the bone is a dragged forward by the other muscles, until it rests upon the anterior marg the glenoid cavity, but within the capsule.

5. Paralysis of the muscles passing from the trunk to the arm, with c quent dropping of the head of the bone, until a great hollow makes its appea beneath the acromion. This may occur in adults, but is more common in born infants, from the pressure of forceps in delivery.

In all of these, however, instead of rigidity and immobility, passive mot

free, and the elbow can be made to touch the side with ease; indeed, it ly is already in contact with it. This is especially true of separation of the ıberosity, where the difficulty is often a very real one. In all the other



—A similar Dislocation, showing the effects of Rotation Outward, Abduction and Traction Backward. The head is just passing over the anterior edge of the glenoid.

FIG. 211—Rotation Outward, to be followed by Abduction.

s crepitus can easily be made out, unless they are either impacted or already united.

**reatment.**—Immediately after the accident, or in a moderately recent

case, when the muscles are relaxed by an anæsthetic, the only difficulty is a mechanical one. The head, for example, no longer corresponds to the rent in the capsule, or it is fixed by the tension of some of the ligaments. After a few hours however, others are added; the muscles contract and become rigid; later still they undergo fibroid degeneration; adhesions form between surrounding structures, the lymph that has been thrown out becomes organized; the rent in the capsule is repaired, and sometimes even the glenoid fossa is filled in.

Reduction is effected partly by the aid of the coraco-humeral band, which now runs downward and inward from the base of the coracoid to the tuberosity, partly by the tension of the short external rotator muscles and the posterior portion of the capsule, which are tightly strained across the glenoid fossa. The first step is to fix the scapula, which may be done by an assistant standing behind and holding it down upon the thorax, while his fingers help to manipulate the head of the bone. This lies underneath the subscapularis or in its substance, suspended

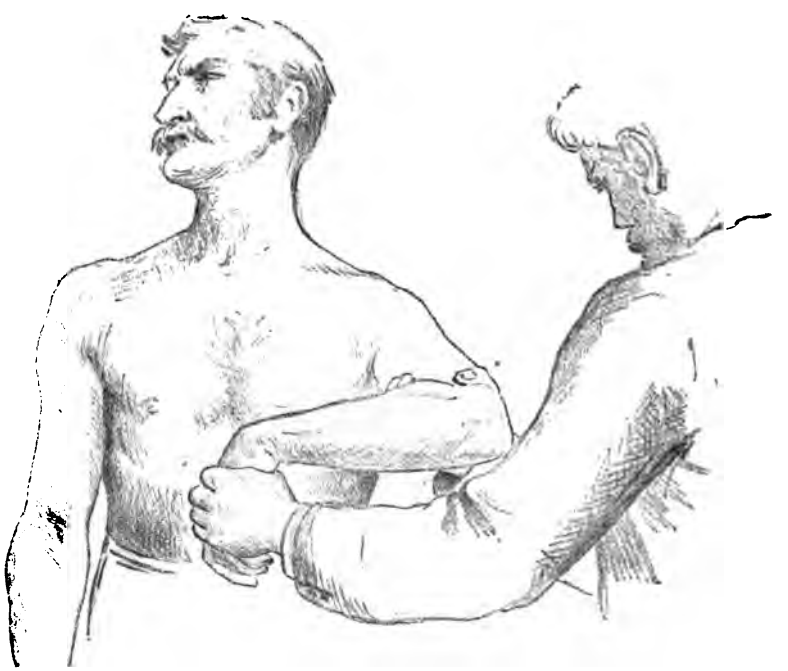


FIG. 212.—Circumduction of Elbow, after Rotation.

were by the muscles and ligaments attached to the great tuberosity, and fixed firmly against the projecting anterior lip of the glenoid fossa (Fig. 209).

In many cases it may be released at once by rotation outward, or rotation combined with traction. If the elbow (which is already flexed owing to tension on the biceps) is pressed firmly into the side, and then the forearm rotated outward as far as it can go, the outer and posterior portions of the capsule, which are strained tightly against the glenoid fossa, are lifted away from it by the great tuberosity; the edges of the rent are held apart; and, if the opening is high enough as in most cases of subcoracoid dislocation, the head of the bone is fixed between the upper and lower parts of the capsule (both of which are still tense) on the anterior lip of the glenoid fossa, close to the spot at which it burst through (Fig. 210). Sometimes then a little outward pressure from the axilla or backward traction from the elbow is sufficient to make it describe the arc of a circle, of which the upper untorn portion of the capsule is the radius, and it slips at once over the edge into its socket. A greater amount of force may be obtained

ing the upper part of the humerus outward, while the elbow is drawn across front of the chest.

If this does not succeed, further manipulation must be tried; the forearm must still be kept flexed and rotated out as far as it will go, but the elbow must now be brought forward until the arm is horizontal (Fig. 211). By this the upper part of the capsule is relaxed, as well as the external rotator muscles, and the only portion left tense is the lower and posterior; this fixes the neck of the humerus and prevents the head from moving further forward. If now the forearm is circumducted inward, so that the fingers touch the other shoulder, the head of the bone is forced to move in the opposite direction and can hardly fail to be carried into its socket (Fig. 212). It is essential, however, that the movements should be carried out slowly and deliberately and to their full extent.

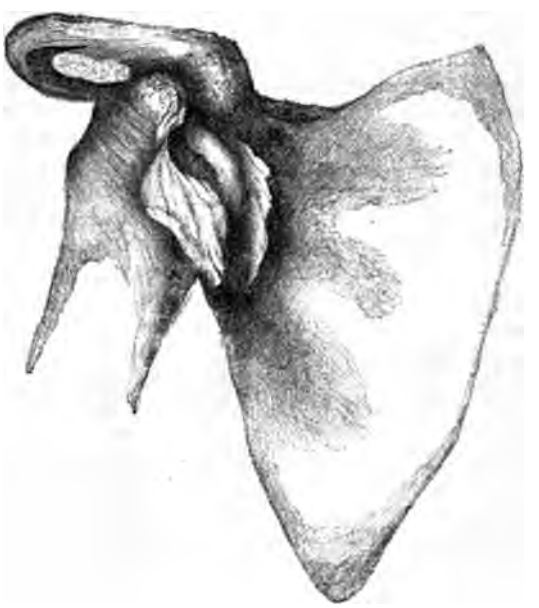


FIG. 213.—Forced Rotation Inward, tightening up the short external rotators and the untorn parts of the capsule.

Inward rotation from the first is simpler still, and is more successful when the rent in the capsule is low down, as in the subglenoid form. The position of the patient is the same; the same precaution must be taken with regard to the elbow and the shoulder; then the arm is a little abducted, drawn down to release the head from the fibres of the muscle that surround it, and rotated in (Fig. 213). The coraco-humeral band and the short external rotators are stretched as tightly as they can be, and the head of the bone travels round the inner margin of the glenoid fossa until it is compelled to rise over the edge. Drawing the

FIG. 214.—Reduction of Dislocation by Heel in the Axilla.

lower end of the humerus across the body, while the upper part is either being pulled or pressed outward at the same time, is of great assistance.

If manipulation and rotation both fail (and even when the patient is under an anæsthetic they will do so sometimes, either because of the peculiar position of the rent in the capsule, or from the changes that occur when the case is left to itself) extension must be tried. The most successful of all methods is by means of the heel in the axilla. The patient is directed to lie down upon a low couch close to the edge; the surgeon (having first removed his boot) seats himself on the edge on the same side as the dislocated arm, facing the patient; he then takes hold of the limb by the wrist, and placing his heel (not the sole) well up in the axilla, so that it comes in contact with the axillary border of the scapula, proceeds to make traction upon the limb in its abnormal direction, slightly abducted, that is to say (Fig. 214). The foot acts as a counter-extending force; the heel and the traction combined fix the scapula; and if the arm is rotated a little or gently swayed from side to side, or if the head of the bone can be manipulated from above by an assistant, it slips out at once, and is carried up by the muscles into the fossa with a sudden snap. In older cases, or when the muscles are relaxed by an anæsthetic, the foot has to act the part of a fulcrum as well; the head of the bone is gradually drawn down until it is disengaged; then the hand is brought across the chest, and the upper end of the humerus is levered outward in the direction of its socket.

FIG. 215.—Clove-hitch.

A greater amount of force may be obtained by means of a jack-towel made into a clove-hitch. A wet bandage must first be placed round the arm to protect the skin as well as to prevent the towel slipping; the clove-hitch is adjusted above the elbow; and the loop of the towel passed over one shoulder of the operator and under the other arm; by this means he can bring into play the extensor muscles of the back and at the same time leave his hands free to grasp the wrist and aid in reduction by rotating and abducting the arm. In cases of still longer standing, in which rotation has failed and it is considered advisable to make further trial, the pulleys may be adjusted to the arm above the elbow in the manner already described.

The same result is aimed at by means of the knee in the axilla (Astley Cooper's method), but it is not so successful; the patient is seated on a low chair; the surgeon stands behind, and resting his foot upon the edge of the chair, places his knee in the axilla; then, grasping the arm above the elbow with one hand, and pressing down upon the acromion with the other, he makes traction downward, and at the same time, by raising his foot upon his toes, forces the neck of the humerus outward, thus combining traction and abduction with leverage.

One other method, that of hyper-abduction, must be mentioned, as the principle upon which it is conducted is rather different, and it sometimes succeeds when others fail. The arm is raised from the side, and abducted until it is in a line with the patient's body; the deltoid and the untorn part of the capsule are relaxed; the acromio-clavicular arch is made use of as a fulcrum, and the head of the bone is first of all pulled downward, and then, as the scapula shifts, pulled out at right angles to the glenoid fossa, until it is sufficiently released to ride over its edge. It may be carried out in various ways. The patient may be seated on the floor, and the surgeon stand on a chair over him; or he may be lying down on a sofa, near the edge, so that nothing can impede the upward movement of the arm (Fig. 216); and counter-extension may be effected, either by making a slit in a towel, passing the arm through it, and then giving it to some one else to hold on the opposite side of the patient, so that the scapula is pulled down upon the thorax —or by the surgeon himself pressing his foot or his hand down upon the shoulder from above and behind while making extension upon the arm. It is scarcely advisable for dislocations of long standing until other measures have been tried and

filled, as, owing to the extent of movement of the head of the bone, it must expose the axillary vessels to a certain amount of risk.

After reduction has been effected the axilla must be dusted over with oxide of zinc powder and carefully padded with cotton wool, partly to prevent any forward displacement of the arm, which might occur from the injury sustained by the muscles attached to the great tuberosity, partly to assist by its pressure in the absorption of the exudation that is thrown out. Then the arm must be bandaged to the side. Passive motion should be commenced not later than the end of the first week; if carefully carried out there is no risk of causing re-dislocation; and it is the best method for checking the stiffness that is liable to occur from confinement of the joint. Whether the limb after that period should be merely carried in a sling, or should each time be secured by bandages again, must depend upon the patient and the amount of care he will take of himself. Active movement should certainly not be allowed for three weeks, and no overhand movement for a much longer period.

### *Unreduced Dislocations.*

Dislocations of the humerus are very frequently neglected or overlooked, and it is by no means uncommon for the patient to apply for treatment for the first time

FIG. 216.—Reduction of Dislocation by Upward Traction.

months after the accident. The question then arises whether an attempt should be made to effect reduction, or whether it would not be better merely to break down the adhesions, and, by means of exercise and passive motion, encourage as far as possible the formation of a new joint. The time that has elapsed is of course the most important element, but it is not the only one—the age of the patient and the usefulness of the arm have to be considered. Up to four months success is common, and may be looked for, and the arm generally recovers; but many instances of failure, more or less complete, after much shorter periods than that, have been recorded. After four months it becomes more and more doubtful each day, although cases have succeeded after as long as two years. The best guide probably is the amount of pain the patient suffers; if it is severe—and sometimes it is so bad as to justify excision of the head of the humerus—the limb is sure to be kept at rest, and will become completely stiff; if, on the other hand, movement is already free and painless, and the part is fairly useful, it is certainly not advisable to try too much. The patient may be placed under an anæsthetic, the head of the humerus rotated from side to side, and the various methods of manipulation practiced, with the prospect, even if reduction is not effected, of materially improving the use of the part; but if, after this has had a fair trial, the head of the bone shows no

inclination to return, it is doubtful whether much improvement is likely to result from the use of the pulleys.

**Complications.**—Dislocations of the shoulder are always attended by bruising and laceration of the surrounding structures; but, unless the injury is very extensive or involves some part that usually escapes, it ought not to rank as a complication. Extravasation of blood into the axilla, for example, rarely deserves to be counted as one, though sometimes, owing to the number of small vessels torn across and the loose spaces in the cellular tissue, it is very considerable in amount; but occasionally *the axillary artery* gives way, or, what is equally grave, one of its large branches is torn off from it, and an arterial hæmatoma of the most serious description forms at once. The axilla becomes distended to its utmost; the pulse at the wrist ceases; the arm becomes œdematous and cold; and the patient falls into a state of collapse. In such a case there is no alternative; the subclavian must be compressed; the axilla opened; the blood turned out; and the artery tied above and below the seat of injury. Only when the swelling ceases to increase, while the arm still retains its warmth and feeling, it is admissible to wait. Possibly, when this is the case, the swelling has become accidentally circumscribed, and an aneurysm will form, which can be dealt with later on; or the opening in the artery has become temporarily blocked by a coagulum, which may not give way again, although it nearly always does. At any rate, in such circumstances there is no need to proceed at once to such a serious operation, although the case must be very carefully watched. Ligature of the subclavian, if the swelling is diffuse, will not check the hemorrhage and may cause gangrene.

It is more common for the artery to be bruised by the head of the bone, but this rarely leads to anything more serious than a temporary cessation of the pulse. Sometimes, however, a thrombus forms, probably from the injury to the inner coat, and the artery is permanently closed; and occasionally an aneurysm develops later on. In a few instances *the vein* has been ruptured as well.

*The brachial plexus*, owing to its strength, nearly always escapes; but there is very often intense pain down some of the nerves, from the pressure of the head of the humerus; and sometimes, probably from the same cause, this is followed by loss of power. It rarely, however, persists for any length of time. *The circumflex nerve* is not so fortunate. Atrophy of the deltoid is not uncommon after dislocations, and though in many instances it is the result of rheumatoid arthritis, setting in after the accident, sometimes at least it is due to the bruising or tearing this nerve has sustained.

The effect on *the muscles* has been already mentioned; the short external rotators suffer the most; sometimes they are completely torn across, or what is equally serious, drag away with them the great tuberosity. The others may be badly bruised, but there is seldom any graver injury; even the long tendon of the biceps, though it is subjected to a considerable strain, is very rarely torn or displaced.

*Fracture of the surgical neck*, whether it is the result of the original accident (the force continuing to act after the dislocation has been produced) or is due to attempts at reduction, is a most serious complication. In the former case the patient must be placed under an anæsthetic, and every effort made to manipulate the bone back into its socket; in the latter, it is probably best to push the upper end of the shaft into the glenoid fossa, and try to establish a false joint. *Fracture of the lip of the glenoid cavity* sometimes occurs, and, like separation of the great tuberosity, is important, as it tends to impair the security of the joint after reduction.

These complications occur much more frequently from trying to reduce dislocations of long standing. Even when the attempt succeeds without much manipulation, the cellular tissue is bruised and torn, the adhesions broken down, and the muscles lacerated to such an extent that, especially if pulleys have been used, it is not uncommon to find the side of the chest and the axilla black and blue for weeks afterward. But worse consequences than these have often happened. The

one, for example, has been broken many times, especially at the surgical neck; it becomes atrophied to a certain extent from disuse, and as soon as any leverage is put upon it, it gives way at its weakest part. The artery has been torn, and though on a few occasions this has been the result of excessive violence, it has happened to the most careful surgeons from mere manipulation. It is probably due to adhesions having formed between it and the head of the bone, so that, when the latter is moved to a very slight degree, the whole of the tension falls on a limited portion of the wall of the vessel. The same thing has happened to the vein: the brachial plexus has been torn out from the spinal cord; the ribs have been broken; the soft parts hopelessly damaged; and even the arm itself has been torn off.

Compound dislocations are very rare, and the treatment must be guided by the amount of injury sustained by the soft structures round the joint; unless these are very extensively hurt, the dislocation should be reduced and an attempt made to save the limb.

## Dislocations at the Elbow Joint.

Under this are included dislocations of the ulna and radius together, of either of the two by itself, and of the two separately, the one being driven forward and the other backward. Of these the first named and dislocation of the radius by itself are common, the others are very rare. They may occur at all ages, but, owing to the smooth and rounded shape of the articular surfaces in childhood, they are much more frequently met with at this period than in any other. All the processes, especially the coronoid, at that time of life are low and cartilaginous; the depressions are not deep or well-defined; and the head of the radius is not only smaller in proportion to the shaft, but is not marked off from it so distinctly as it is in later years.

### *Dislocation of Radius and Ulna together.*

This may be complete or incomplete, that is to say, the two bones may either have lost all relation to the lower end of the humerus, or they may still be to a certain extent in contact with it, and it may take place in any one of the four directions, backward (Fig. 217), forward, outward, or inward; or it may be diagonal, backward and outward, or backward and inward. Of these the dislocations backward, and backward and outward, are the two most common; the others are very rare, the prominence of the olecranon prevents one, the direction and shape of the trochlear surface of the humerus prevents another, and complete lateral dislocation in either direction can hardly take place without the injury becoming compound.

Fig. 217.—Dislocation of Bones of Forearm (Back).

**Causes.**—These injuries are nearly always the result of a fall upon the hand, with or without violence applied to the elbow itself, but the way in which they are produced is not always the same. In many cases they are due to over-extension: the tip of the olecranon is pressed against the posterior surface of the humerus, and forms the fixed point; then, if the force continues, the strain falls upon the anterior ligament, the biceps and brachialis anticus being either overcome or taken unawares; the sigmoid cavity of the ulna is separated from the trochlea, and the two bones are carried together, behind the humerus, until the coronoid process passes the centre of the articular surface. If it is carried right up to the olecranon fossa (it cannot lodge in it so long as the radio-ulnar ligaments are intact), the dislocation is complete; if it falls short of this it is incomplete.

humerus, wholly or in part, displacement
process, and effusion into the bursa behind
es a deformity something like that of a

difficulty. It is true there is a prominence
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being carried backward; but the former
l like the articular surface of the humerus,
and reappear by making or relaxing exten-
being rigid, there is undue mobility, the
at once; crepitus can usually be made out,
ad of the radius and the olecranon preserve
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ner condyle; but in children, if the outer
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if the olecranon fossa becomes partly filled
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s to fix the humerus, pressing it somewhat
on the forearm in the extended position;

wrist is at the end of the long arm of a lever; the knee is the fulcrum; and [illegible] olecranon the short arm. The resistance to be overcome is made up of the [illegible] ties on both sides of the joint), the lateral ligaments and the fascia; all of th[ese] structures must be torn or stretched sufficiently to allow the coronoid to slip un[der] the humerus while the arm and forearm are at right angles to each other. T[his] method is very successful; but if these structures are not already torn, they m[ust] give way, owing to the force that is used.

Fig. 218.—Unreduced Dislocation of Elbow.

The after-treatment is very simpl[e]. There is no fear of recurrence, as in th[e] case of the humerus, unless the coronoid has been broken off; but the amount of e[f]travasation and swelling is sometimes ve[ry] considerable; and especially in children there is some risk of inflammation settin in. The limb should be placed on an i[n]side angular splint, and cold and compre[s]sion applied until the swelling has go[ne] down and the fear of inflammation is passe[d]. Passive motion may in ordinary cases [be] commenced at the end of a week; aft[er] that, unless there is something unusual, [it] is sufficient if the forearm is supported [in] a sling. Perfect movement is general[ly] regained, unless there has been a fracture through the lower end of the humerus.

Old dislocations may be reduced up to the end of three weeks or a month without much difficulty: after that it becomes doubtful, and though reduction has been accomplished as late as four months, this is quite the exception (Fig. 218 is one of two cases in which all attempts have failed, and the position of the ar[m] has been such that it was almost useless, the olecranon has been sawn through transversely from behind, the joint opened up, all obstructions divided, the muscl[es] separated from the condyles, the olecranon fossa and the sigmoid cavity clean[ed] out, and the bone replaced. The olecranon must be wired together and the lim[b] treated as after excision of the elbow. In some cases there has been distinct im[pro]vement, but in others, especially those in which there was at the same time a fracture through the lower end of the humerus, the gain was not great; if su[ch] a case sets in bony ankylosis is almost sure to follow.

Compound dislocations must be treated in the same way as compound fra[c]tures into the elbow joint. The question turns first on the age and condition of the patient, then upon the extent of injury to the soft structures; and the choi[ce] lies between reduction, with an attempt to secure primary union of the wound [by] antiseptics with free incision, and thorough (very thorough) drainage; excision, [or] amputation.

### *Dislocation of the Ulna by itself*

[This] is a rare occurrence, and is generally accompanied by partial displa[ce]ment of the radius. Sometimes the separation is carried so far that the ligame[nts] between the two bones are torn completely across, and one is displaced forwa[rd] and the other backward. This can only be produced by extreme pronation; [the] radius is fixed on its axis until the internal lateral ligament gives way a[nd] the ulna passes behind the internal condyle. The forearm is held semi-flexe[d] and pronated.

### *Dislocation of the Radius*

[This] may be forward, backward, or outward; the first is the most comm[on]. In adults it seldom occurs unless there is fracture of the ulna, [or] of the upper part of the bone, and then wrenches the radius from its socket. [It] is comparatively frequent, owing to the small size of the head, the absence

tinction between it and the shaft, and the comparative looseness of the orbicular ament. The rent in the capsule is not always the same; in adults the ligament ears generally to be torn away from one or other end of the lesser sigmoid ity; in infants and children the head of the bone either slips out from under r is forced through it, just where it is joined by the fibres of the external lateral ament. Probably this serves to explain the serious difficulty that is occasionally et with in reduction.

**Causes.**—Dislocation of the radius by itself is nearly always the result of in-ect violence—a fall upon the palm of the hand; but sometimes it is produced pulling upon the forearm (swinging a child by the hand, for instance), and ere are a few cases on record in which it has resulted from force applied directly the elbow, the external condyle of the humerus or the capitellum being crushed st.

It is very doubtful if it can be produced by mere pronation; if this is carried its fullest extent it makes the head of bone project against the front of the cap-ule; but before this gives way, either the internal lateral ligament tears across nd both bones are dislocated backward, or the radius itself breaks. The ulna in the living subject cannot act as a lever for the radius. It is possible that it may be effected by supination; but probably not as a rule, for, if the hand is violently upinated, the inferior radio-ulnar articulation gives way first, and then either the adius, or, in children, the lower epiphysis of the humerus. If, however, forcible lateral bending of the joint (adduction or abduction) is combined with pronation or supination, the orbicular ligament gives way readily, and the head of the bone is carried either forward or backward, according to the position of the elbow at the moment and the direction of the force. In a fall upon the hand the limb is nearly or quite extended; its lower extremity is fixed against the ground; then the momentum of the body drives the elbow joint to one side or the other, and at the same time violently pronates or supinates the forearm.

**Symptoms.**—The signs of this injury are usually distinct; the head of the radius projects, either in front of the joint under the supinators, or behind in the hollow below the external condyle; and its peculiar shape can be recognized at once on rotating the hand. The elbow is flexed; the radial side of the forearm appears shortened; generally it is moderately pronated, and sometimes this is extreme; voluntary movement is very much restricted, and passive motion, especially when the displacement is forward, is limited by the head of the bone coming into contact with the anterior surface of the humerus. In older cases, when the articular end has become wasted and has worn a cavity for itself, this is more free; and sometimes, when it can slip to one side, a considerable degree of flexion is possible, but this is not common. The depression left by the displacement of the bone can always be felt below the external condyle.

**Treatment.**—Reduction may, as a rule, be readily accomplished by fixing the humerus, making extension from the hand, and pressing the head of the bone into position; but every now and then great difficulty is experienced, probably owing to the intervention of a portion of the capsule; and sometimes, in spite of manipulation in all directions, and pronation and supination, reduction remains impossible. If the orbicular ligament has given way, the difficulty of retaining the head of the bone in position is equally great; an anterior rectangular splint may be tried, or the limb may be put up in a position of complete extension with a pad over the head of the bone. If this fails, complete flexion sometimes answers, having regard to the circulation; but the condition is not unlikely to become permanent. Unreduced dislocations of the radius are not uncommon. If the head of the bone gives rise to serious inconvenience, if, for example, it prevents flexion of the elbow, or, from pressing upon the posterior interosseous nerve, interferes with the extensor muscles, it must be excised. Generally the arm regains a good deal of its power, partly no doubt because of the age at which the injury usually occurs; but pronation and supination are never very satisfactory.

### *Subluxation of the Radius.*

This accident, which was first correctly described by Duverney, is com in children under three years old, but is hardly ever met with after six. I always produced in the same way: traction with adduction and possibly pro tion. A young child is lifted up or swung round by the hand; there is a sudd cry of pain, and when the arm is released it either hangs helplessly down by t side or is supported across the chest in the flexed position. Nor is the child a to use it. In most cases no displacement can be found; sometimes the head the radius appears slightly prominent in front, or is a very little separated fr the capitellum; and sometimes there is a certain amount of swelling at the b of the wrist. Passive motion is perfectly free, and alm painless—in all directions except supination; that sto rather abruptly; and there is distinct tenderness and pain the outer side of the elbow when it is attempted. In a fe instances the wrist has been painful too.

FIG. 219.—Subluxation of Radius in an Infant. Shows supinator brevis and orbicular ligament turned aside, showing head of radius. Externally is seen the musculo-spiral nerve and its two branches, the radial and interosseus nerves.

From experiments on dead subjects (there are no pos mortem records) it is tolerably clear that the symptoms ar caused by the head of the radius being drawn out from inside the orbicular ligament until its anterior edge catches and i held below the lower border of the ring, thus slightly sepa ating it from the capitellum (Fig. 219). If in additio there is forced pronation, the head of the bone projec slightly in front (Pingaud). Possibly in those cases in which extreme pronation is the prominent cause, the displacement is made worse by the posterior portion of the head of the bone separating sufficiently from the capitellum to allow a portion of the capsule to be squeezed in between the two bones by atmospheric pressure. In either case reduction is usually effected at once by sudden extension combined with supination (J. Hutchinson, junior, recommends pronation with flexion); probably in many instances it takes place spontaneously; but, as Stimson remarks, there is reason to think that some cases of forward dislocation of the radius found in adults, persisting from childhood, were originally of this kind, the head of the bone gradually being displaced further and further.

Where the pain and swelling are confined to the back of the wrist joint, without the elbow showing any sign, or where both parts are affected together, it is possible, as suggested by Goyraud, that the injury really consists in a dislocation of the triangular fibro-cartilage from the lower surface of the ulna.

### DISLOCATION AT THE WRIST JOINT

is a rare form of accident, which formerly was often confused with Colles' fracture. The carpus and hand are detached from the radius and fibro-cartilage and carried either toward the dorsum or the palm, according to the direction of the force. The projection on the back of the wrist, in the one case corresponding to the articular surface of the carpus, in the other to the lower end of the radius and ulna, can be recognized from its shape; but the most important sign is the position of the styloid processes; in dislocations their relation is normal; in fracture the radial one is separated and follows the hand. Reduction is easy, but, in spite of passive motion, is liable to be followed by stiffness.

Dislocation of the lower end of the radius, with rupture of the triangular fibro-cartilage, may occur from extreme pronation or supination.

In the transverse carpal dislocation the distal row of bones is separated from the proximal, and is driven either toward the palm or the dorsum; in the metacarpal the bones of the hand are displaced; but though this is not unfrequent in the case of the metacarpal bone of the thumb by itself, and occasionally happens to the fingers, there does not appear to be any instance in which it has involved all at once.

Dislocation of the os magnum by itself is not uncommon, the head of the bone being tilted out from the concavity of the semilunar by a fall upon the back of the hand. The projection can be recognized at once and is easy to reduce, but it is very apt to recur, even though the hand is kept extended for two or three weeks. It is stated to be more common among women than men, and it has been produced by violent muscular contraction during parturition.

The pisiform bone, with the tendon of the flexor carpi ulnaris, is occasionally dislocated to one side, but this rarely happens to any of the others. They may be crushed and displaced in severe accidents, but then the injury is nearly always compound and must be treated as a compound fracture into the wrist joint.

### Dislocation of the Metacarpal Bone of the Thumb

is nearly always dorsal, and may be easily recognized by the prominence on the trapezium and the shortening of the thumb, which is usually flexed. It may be the result of direct violence, as in the bursting of a gun, or of forced flexion into the palm of the hand. Usually there is no difficulty in the reduction, but sometimes it is almost impossible to keep the bone in position, probably because, in some of these instances at any rate, there is an oblique fracture running through the bone, detaching the palmar portion of its base.

### Dislocation of the Proximal Phalanx of the Thumb.

This, too, is usually dorsal (Fig. 221), palmar displacement being prevented by the contact of the soft parts in flexion. The cause is forced extension; the palmar ligament is torn from the metacarpal bone close to its attachment, and the phalanx is carried backward over the articular surface, until in complete cases it rests upon the neck, projecting almost at a right angle. One lateral ligament is generally torn, but both have been found intact; the tendons of the flexor brevis with the sesamoids lie on either side of the neck, and the distal phalanx is bent down by the tension of the long flexor, which usually lies to the inner side of the head of the metacarpal.

Reduction is sometimes quite easy; more often it is a matter of very great difficulty, and, occasionally, it cannot be effected at all. Chloroform is of very little help, and the numerous forceps that have been invented are not much more, for if the attempt succeeds it generally does so at once, and the hold on the thumb is quite sufficient (Fig. 220).

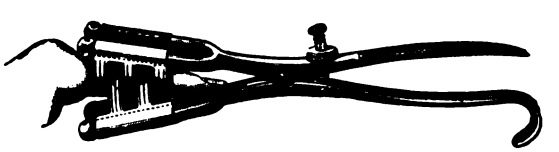


Fig. 220.—Thumb Forceps.

The head of the metacarpal bone is prolonged inward on its palmar aspect, so as to form a rounded eminence for articulation with the sesamoid bones. These are firmly united to the phalanx and to the palmar glenoid ligament which separates the long flexor tendon from the joint, and extends up on either side of the head, forming a large share of the socket. On the other hand the fibro-cartilaginous pad is very loosely attached to the metacarpal bone; and when dorsal extension is carried too far, tears off at once, and with the sesamoids follows all the movements of the phalanx.

Three forms of this dislocation have been described by Faraboeuf, differi degree.

1. *Incomplete.*—This can be produced in many young people volunt The articular surfaces are not completely separated, and the phalanx is held the tension of the muscles attached to its base, rigidly fixed on the dorsal of the articulation, from which it slips off with a jerk.

2. *Complete.*—The articular surfaces completely separated; the base of phalanx rests upon the dorsum of the metacarpal, dragging with it the gle ligament (which has been torn off) and the sesamoid bones; the tendon of long flexor lies to the inner side (generally) and the head of the metacarpal p jects through the rent in the capsule embraced by muscles attached to the phalanx. The proxi phalanx projects at right angles, the terminal one flexed strongly, and the head of the metacarpal sta out under the skin (Fig. 222).

FIG. 221.—Dislocation of Proximal Phalanx of Thumb.

3. *Complex.*—If, in a complete dislocation, t phalanx is brought into a straight line with the met carpal, the tension of the muscles on the sesamoi bones may pull them (and the glenoid ligament wit them) backward over the dorsal surface of the met carpal until they lie flat upon it. If, now, reductio is attempted the ligament is dragged over the head the metacarpal by the phalanx until it is interpose between the two bones and effectually prevents prop apposition (Fig. 223). This has been found by disse tion on several occasions; in another a sesamoid bo was in the way, and in three, at least, the long flex tendon had followed the ligament round the head the bone, so that reduction was impossible until it w divided. Exactly the same occurs sometimes in th case of the fingers.

According to Faraboeuf, complete dislocations a rendered complex by ill-advised manipulation, especially by premature attemp at flexion. The metacarpal bone must be pressed well down into the palm t relax the short muscles as far as possible; then the phalanx must be over-extende

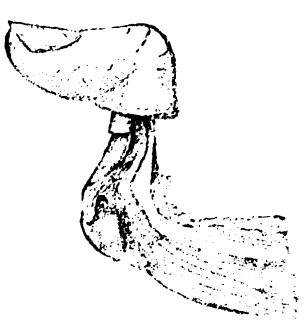


FIG. 222.—Complete Dislocation of phalanx of Thumb. The glenoid ligament torn from the metacarpal but preserving its normal relation.

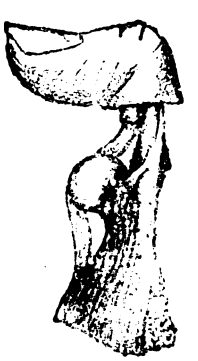


FIG. 223.—Complex Dislocation. The glenoid ligament displaced on to the dorsal surface of the phalanx.

until its back nearly touches that of the metacarpal, and pushed forward along until its edge slips on to the articular surface; then it suddenly becomes flex The position of the long flexor tendon, whether it lies to the inner or the ou side, should, if possible, be made out, as this is sometimes material. The fort

the more common, and then as the phalanx is being brought up it should be slightly rotated, so as to bring its inner edge into position before the outer, and, if possible, push the tendon over the head of the bone in front of it.

In the complex form, when the sesamoids and the glenoid ligament are turned up behind the head of the metacarpal, the only hope lies in extreme extension of the phalanx, so that its dorsal surface shall touch that of the metacarpal before it is pushed on. In this way they can sometimes be lifted sufficiently to fall into their position again.

If this fails it is better to abandon the attempt for a time and to keep the joint perfectly cool and quiet for a week or ten days; then a free incision may be made down one side, the cause of the difficulty ascertained and removed. Tenotomy of the flexor brevis has been recommended, but if the cause is the interposition of some extraneous substance it would hardly meet the case. Division of the long flexor has been successful, and probably it would have succeeded in the three cases in which the tendon was found between the surfaces. No operation, however, may be attempted at once, or, owing to the bruising of the tissues, suppuration is almost certain to set in. As a last resort the joint must be excised.

Old unreduced dislocations are not uncommon; the phalanx can be bent back almost on to the metacarpal, but cannot be brought quite into the same straight line, or flexed into the palm. The deformity is very unsightly, but the use of the part is, singularly, little affected.

FIG. 224.—Dislocation of Finger.

Similar displacements occur in connection with the metacarpo phalangeal and the inter-phalangeal joints of the fingers; the deformity is not so great as that of a real dislocation, and it cannot be rectified. In some instances the fibro-cartilaginous palmar ligament has been found between the bones, and has been removed; in one under my care the first attempt proved successful after division of the flexor tendon.

Besides this, true dislocations, both palmar and dorsal (Fig. 224), are met with, but much more rarely.

## DISLOCATIONS OF THE HIP-JOINT.

In spite of the shape and depth of the acetabulum and of the strength of the muscles and ligaments that surround it, this accident is not so uncommon as might have been expected. This is due partly to the enormous leverage afforded by the lower limb, partly to the fact that in certain positions the head of the bone sinks to a great extent out of the cavity and rests against the weakest portion of the capsule. It may occur at any age, but naturally is much more common during adult life; in children it has occasionally been produced by direct traction upon the limb; as a rule it only results from extreme violence, when, for example, a man is crushed to the ground by a heavy weight falling on his back as he is stooping forward.

### VARIETIES.

The head of the bone may come to rest at any point round the socket; but so long as the anterior portion of the capsule is untorn, its range is limited and it practically occupies one of three positions. These are known as regular dislocations, each having many sub-varieties, in contradistinction to the irregular or

anomalous ones, in which, owing to this part of the capsule having given way, neck of the femur is no longer fixed and the head may travel anywhere.

1. *Displacement Backward.*—The head of the bone rests on the dorsum the ilium (Fig. 225), or on the posterior surface of the ischium (Fig. 226), som where between the edge of the acetabulum and the margin of the great sacro-sci foramen; possibly on the spine of the ischium, but never in the foramen.

2 *Displacement Downward.*—The head of the bone rests on the thyroi foramen (Fig. 227), hardly having moved after its immediate exit from the aceta bulum; or it is carried further still into the perineum.

3. *Displacement Inward* on to the pubes, at the spot where the horizont ramus joins the ilium (Fig. 228).

In none of these is the anterior part of the capsule, the so-called Y ligamen torn; the rent lies behind, generally along the inner margin of the acetabulu and the posterior surface of the neck of the femur; the ligamentum teres is pulle in two, or more frequently separated from its pit on the femur, bringing away wit it some of the articular cartilage; and the muscles round the joint, especially th short external rotators, are badly lacerated.

*The Mechanism of Dislocation.*—Except perhaps in pubic dislocation (whic may be produced in extension) the limb is always flexed. If it is flexed an adducted, the head of the bone is driven directly through a tolerably strong pa of the capsule on to the ilium or ischium; if it is flexed and abducted, the edg of the acetabulum acts as the fulcrum of a lever, the head is tilted out from it socket and slips through where the fibres are thinnest, at the lower and inne margin. Then it becomes displaced secondarily, either backward or forward, b the weight of the limb and the contraction of the muscles. It is still a matter o question which of these two (the direct or indirect) is the more common.

The shape of the acetabulum certainly favors the latter; the upper and bac part of the cavity is of immense strength and very deep; the inner, on the othe hand, is low and interrupted for nearly an inch by the cotyloid notch. In abduc tion the head of the bone rolls more and more toward this side until it project above the edge, half resting against the weakest portion of the capsule. In thi position a very slight push is sufficient to tear the thin membrane across, and, th round ligament being relaxed, to dislocate the head of the bone. Its ultimat resting-place is regulated by the degree of flexion and rotation. Sometimes i moves slightly inward and remains on the thyroid foramen. Very rarely, onl indeed when the limb is everted and extended, it ascends on to the pubes. Muc more often, owing to the inversion of the head, it forces its way backward, belo the tendon of the obturator internus, and either remains upon some part of th ischium, or, if the capsule and the short external rotator muscles are badly torn makes its way higher up until it lies upon the dorsum (Fig. 230). According t this view, which is strongly advocated by Morris, all dislocations are primari downward, the head of the bone emerging somewhere between the ischial tube osity and the thyroid foramen; the other varieties are merely consecutive displac ments, due partly to the weight of the limb as it becomes extended, partly muscular contraction; and the particular variety is dependent upon the positi of the limb at the moment that the head is leaving the socket.

Now it is certainly true that sometimes during manipulation under an an thetic instead of the head of the bone rising up into its socket, it rolls along lower margin of the acetabulum, passing from the thyroid foramen to the ischi and back again, according to the position of the limb; and there is no doubt t all the four regular dislocations can be produced in this way in the dead subje but it is no less true that this explanation will not serve in all cases. In ma instances (probably in most) the limb, instead of being abducted, is stro adducted at the moment of the accident; further, the rent in the capsule does always run along the thinnest part, by the margin of the acetabulum and the te terior surface of the femur. The pubo-femoral portion of the capsule may intact; and, as Humphry has shown, there may be at the back a tri-radiate r

## *DISLOCATIONS OF THE HIP JOINT.*

FIG. 225.—Dorsal Dislocation.

FIG. 226.—Sciatic Dislocation.

FIG. 227.—Thyroid Dislocation.

FIG. 228.—Pubic Dislocation

forming a kind of valve, with its apex opposite the lower part of the tube
Such an injury can only be produced by the head of the femur being driven di
backward, in the flexed position. If the joint is nearly straight at the mome
limb receives the shock, the lip of the acetabulum may be chipped off; if m
ately flexed, the head of the bone is driven out, above the obturator interm
through its substance, tearing the capsule away from its attachment, or draggi
part of the bone (Fig. 229); when the flexion is extreme (as it nearly alwa
in these accidents) the head passes out beneath the tendon (Fig. 230), and e
comes to rest upon the ischium, or, if the force continues to act after the disl
tion is produced, tears its way further through the muscles until it reaches
dorsum.

*Dislocation Backward.*

This is by far the most common, and includes both the dorsal and the sci
varieties; they are produced by the same kind of accident; the attitude of
limb is the same, although it varies in degree; and the method of reduction is

FIG. 229.—Dislocation on to Dorsum above the Tendon.

FIG. 230.—Dislocation on to Sciatic Notch below the Tendon. Secondary displacement brings the two almost into the same position.

same. The difference depends upon the position of the rent in the capsule
the extent of the injury to the muscles. If the opening is high up, the displ
ment is dorsal from the first; if the lower part is torn, it is sciatic; but, if
rent is large and the short external rotators are much lacerated, the head of
bone plows its way up subsequently, and the sciatic dislocation becomes do
by secondary displacement.

**Causes.**—The most common is a violent blow upon the back, while the bo
is bent forward in a stooping position. The hip is always flexed; if the limb
adducted and inverted, the pelvis is driven down on to the femur until the head
the bone is forced through the capsule; if it is abducted and inverted, the pel
is twisted, the head of the bone tilted out of the lowest part of the socket, a
then forced below the tendon of the obturator internus. The ultimate position
the same, because that is dependent upon the untorn portion of the capsule a
the muscles. Other causes are falling with the legs wide apart; sudden abducti

limb when the other slips down a hole; or a wheel passing over the hip. A case of double dislocation is especially important: a man was standing on an line with his feet wide apart, the right leg being lower down and therefore lighter than the left; suddenly he was crushed to the ground by a heavy weight ing upon his back; both hips were dislocated at the same instant; the at, which was least flexed, was driven on to the dorsum; the left on to the sciatic ch.

**Pathology.**—The round ligament is almost always broken; sometimes it is lled away from the bone; the inner or posterior part of the capsule is torn, as scribed already; or the back part of the acetabulum is dragged off; the short ternal rotators always suffer; in some cases they are completely ruptured, and the ead of the bone lies in the substance of the glutei; in others the quadratus femoris and the inferior gemellus only are lacerated, though the rest are bruised by the pressure of the bone; the pectineus usually gives way, and the psoas and iliacus are very much stretched. Occasionally the great sciatic nerve is seriously injured, either from the accident itself or from the efforts at reduction. The anterior part of the capsule is always intact; generally it is very tense, but this is not invariable.

**Symptoms and Diagnosis.**—Dislocation on the dorsum can be recognized at once by the position of the limb. The thigh is flexed, adducted, and inverted until the axis of the femur crosses the lower third of the opposite one; the knee is semi-flexed, and the ball of the great toe rests upon the instep of the other foot. In the sciatic this is less conspicuous: the limb is nearly straight, and almost extended, although immediately after the accident the inversion is sometimes even greater. The contour of the hip is altered, the extent varying with the condition of the patient. The buttock is flattened, and broader than the other; the gluteal fold is raised, and the trochanter more prominent; it rises above Nélaton's line, and approaches the anterior superior spine; but in this respect again sciatic dislocation is much less distinct than dorsal.

The next thing is to confirm this by measurement. The limb is always shortened, in the dorsal dislocation as much as two and even three inches; in the sciatic rarely more than one; and as this takes place entirely at the hip-joint, it may be appreciated best by Bryant's triangle, the three sides of which all measure less than normal. It is noteworthy that in sciatic dislocation, owing to the head of the bone lying behind the acetabulum, though the amount of shortening is slight when the limb is extended, it becomes very conspicuous as soon as it is flexed to a right angle (Fig. 231).

The head of the bone can be generally felt by deep pressure where the dislocation is on the dorsum, unless the patient is very stout; but this is rarely possible in the sciatic form, even when the limb is rotated from side to side. There is often, it is true, a sense of resistance; but that is all. In one or two instances the head of the bone has been felt per vaginam. In front, the hollow left can be readily appreciated, even in a moderately stout person, the femoral vessels seeming to dip back suddenly after passing under Poupart's ligament. In thin people the finger seems to sink almost into the acetabulum.

Passive motion, which should always be left to the last, is conclusive. If the knee and hip are flexed, so that the sole of the foot rests on the bed by the side of the other knee, it is impossible to evert the limb; the opposite side of the pelvis rises at once. In any case of fracture (except in that very rare accident in which the head of the bone is driven through the floor of the acetabulum), if the limb is not already in this position, it can be made to assume it so easily that it appears to fall out almost of its own weight.

Voluntary movements are very much restricted; of passive ones flexion is the least affected; the limb cannot be completely extended, and abduction, adduction, and rotation are all limited. Sometimes, however, in a sciatic dislocation a few days old the range of passive motion is nearly as wide and as easy as in the unin-

Reduction may be effected either by vertical extension or lev dorsal form, only adduction and inversion must be used instead of eversion. The patient should be placed under an anæsthetic, right on to the abdomen, bringing it gradually into its normal lin attempt made to lift it vertically upward into its socket. If this do in spite of lateral movements to release the head and stretch th rotation must be tried. The limb is flexed to a right angle, ad inward and extended. The mechanism is the same as in the dors the degree of flexion or adduction is too great, the head of the bo the lower margin of the acetabulum in a similar way (but in the o tion), instead of rising over the edge.

### *Pubic Dislocation.*

Dislocation on to the body of the pubes, not merely on to th bone, is still more rare. It can only occur when the limb is ext ducted, and it may be caused either indirectly by this movement bei far, or directly by violence applied to the back of the hip. The hea rests upon the point of junction of the ilium with the pubes, outsi vessels, and under Poupart's ligament. The rent in the capsule is up than usual ; the round ligament, the pectineus, and the abducto more or less torn, and sometimes Poupart's ligament ; and the s rotators, especially the obturator internus, are forcibly stretched and down.

The limb is everted, abducted, and nearly straight. The troch sunken than in the thyroid form, the head of the bone can be felt its new situation, and in most cases can be seen. There is shorteni to the extent of an inch. Flexion, without drawing the head of the or abducting the limb first, is only allowed to a slight extent ; abduc free.

The mechanism of reduction is the same as for thyroid disloca because of the position of the head of the bone, the limb must be ab it is being flexed so as to bring it round the acetabulum. Vertical ex fail, owing to the capsule being torn more on the inner side than below tion is nearly sure to succeed ; if it does not, extension, with direct pr the head and the upper part of the thigh, must be tried.

### Anomalous Dislocations.

Besides these dislocations there are others, either intermediate in acter or exaggerated, owing to the amount of laceration and to the di the head of the bone has been carried. Generally speaking, they may b round the regular forms and classified, either by the attitude of the li method of reduction. The head of the bone, for example, may rest ischium immediately below the acetabulum, opposite the point from wh escaped, without passing either forward or backward. Secondary dis has been in some way prevented, and the limb is inverted and strong (This may be compared with the luxatio erecta of the humerus.) From the head of the bone may be carried toward the tuberosity, or on to som the margin of the great sacro-sciatic foramen, until it is fixed in one of nary positions.

In other cases the head of the bone is forced so far inward that it pas the obturator foramen into the perineum, and the abduction, flexion, and become extreme. I have seen, in a case of this kind, the thigh laid compl its outer side and flexed to less than a right angle.

Most of these irregular forms, however, belong to the pubic group ; t of the bone may lie just internal to the anterior inferior spine, or it may be

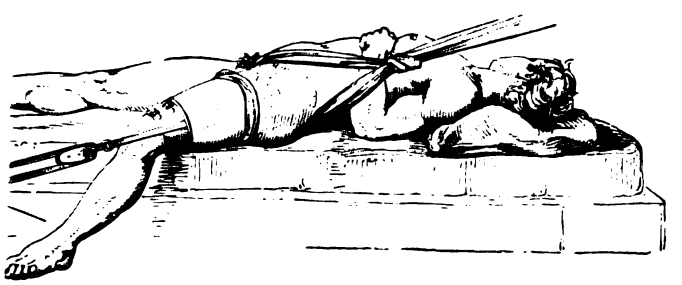
ve it, until it rests in the notch between the two spines (the . The attitude of the limb and the other symptoms are the c form, only much exaggerated, and reduction must be ame way, by abduction and flexion first, and then inversion, sion.

nt.—It occasionally happens that, after reduction has been ad of the bone slips out again as soon as the effects of the In old dislocations this may be due to the cotyloid cavity ; in recent ones it is the result either of some portion of the into the acetabulum in front of the head of the bone, or to g dragged away. In either case reduction must be effected lint and weight extension applied before consciousness returns, he position being maintained. The limb should be kept quiet least four weeks.

y circumstances, where there is no tendency to redisplace- to confine the limb between sand-bags, and passive motion at the end of a week.

### Old Dislocations.

than two months' standing, there is a fair prospect of success ; tion was accomplished at the end of a twelvemonth, but this



g the Fashion of Applying Pulleys. (N B —The leg and thigh should be bandaged.)

as quite exceptional. Manipulation under an anæsthetic affords hance than extension, even with the aid of pulleys (Fig. 232). e bone is not reduced, the adhesions are broken down, the range much improved, and, especially in the sciatic form, the limb deal of its strength and activity, a new cavity gradually being e head. Care, however, must be taken not to fracture the femur, ten atrophied from disuse, or to injure the sciatic nerve, which und around the neck of the bone. Both of these accidents have recent dislocations, but they are much more likely to happen in

the head of the bone has been performed in several cases with a result, though the operation is a serious one. If the head is fairly e position of the limb faulty, subtrochanteric osteotomy may be

## DISLOCATION OF THE PATELLA.

e dislocated to either side, or it may be twisted on its vertical axis rticular and cutaneous surfaces are almost reversed. Displacement ly be regarded as a part of rupture of the ligamentum patellæ.

Outward dislocation is the most common, especially if there is any gen gum. It can only occur in extension; the patella then is so loosely held t can be pushed from side to side, and can be dislocated either by muscular a or by a sudden blow from its inner border, tilting it out over the external co in flexion it sinks in between the condyles and is held strapped down by the t of the muscles. If the dislocation is complete, the articular surface rests a the outer side of the external condyle; if it is only partial, the bone is not c so far and the margin looks forward. Laceration of the capsule is very ge but apparently not absolutely essential. Dislocation inward and rotation are very rare; the latter has been produced by a violent blow upon the inner sid the bone when the knee was bent to an acute angle.

The deformity can usually be recognized at once; the limb is extended very slightly flexed; the knee is flattened in front and broader than natural; hollow can be felt between the condyles; and the shape of the patella, with ligamentum patellæ and the tendon of the quadriceps, both of which very tense, can be seen standing out beneath the skin. Movement is limited.

**Treatment.**—Generally, if the hip is flexed, the knee extended, and di pressure made upon the prominent border of the bone, it slips back into its p tion at once; or, if this fails, the hip and the knee may be bent (under an a thetic) and pressure and extension tried together; sometimes rotation of the has been found of assistance. But, while one or other of these nearly always ceeds at once, instances are occasionally met with in which reduction is impos in spite of every attempt. Nor is the cause clear. It may be due to the pa catching in the intercondyloid notch, or to its being in some way entangled i capsule; but, whatever it is, in a few cases it has resisted everything, and the location has remained unreduced in spite of section of the ligaments and tendon of the quadriceps. In such circumstances it would be wiser to open joint freely, with every antiseptic precaution, and divide the structures that r the bone, than to trust to force and subcutaneous section, which on several sions have ended in suppuration.

As in all injuries involving the knee, the joint becomes filled with fluid before the dislocation is reduced; and partly for this reason, the capsule beco stretched and softened by the effusion, partly because the dislocation is due in measure to the shape of the bones, recurrence is very common. The limb be placed upon a splint, in a position of moderate extension, carefully packe cotton-wool, and firmly bandaged until the effusion is absorbed. Afterwar apparatus must be worn to prevent any lateral movement of the patella. simplest, perhaps, is a piece of chamois leather spread with lead plaster stra round the limb; it should be large enough, when the knee is laid upon it, to lap well in front, and should extend a few inches above and below the joint. answers better than ordinary strapping, unless it is applied exceedingly well. however, there is much laceration, or if the bone has been displaced more once, some apparatus similar to that used to retain a displaced fibro-cartila advisable.

In young people of rapid growth, when the bony prominences are p marked and the ligaments yielding, the patella can be moved freely from one dyle to the other, and sometimes it gets caught upon the outer one. The cap however, is not torn; the bone is easily replaced; and there is a very s amount of effusion afterward.

## DISLOCATIONS OF THE KNEE.

The leg may be dislocated backward, forward, or to either side; and cases are recorded in which the tibia has been displaced so far by rotation tha inner tuberosity was directed forward and the tubercle outward.

*Lateral dislocations* are the most common and are always incomplete, the tibia never being displaced entirely from the femur. This may be caused by a fall with the leg bent under the body, by sudden forcible twisting, or by extreme violence applied to one side of the limb; and are always attended by very serious injury to the lateral and crucial ligaments and to the tendinous expansion of the vasti. The deformity is sufficiently conspicuous to be recognized at once, the internal condyle of the femur resting on the outer tuberosity of the tibia (or *vice versâ*) and forming a distinct and easily recognized projection on the side. Reduction, owing to the extent of the injury, is easily accomplished by flexion and extension combined with lateral pressure. Afterward the knee must be placed upon a splint, raised, very carefully bandaged and covered with ice. Passive motion may be commenced in a fortnight or three weeks, but through a very small angle, so as not to throw any strain upon the ruptured parts; and the patient should not be allowed to bend the joint himself for at least a month more. Afterward an apparatus must be worn restricting the movement of the joint, for fear of any sudden twist displacing the bones again.

*Antero-posterior Dislocation.*—Dislocation of the knee forward may take place either by over-extension or by direct violence: dislocation backward, which is much more rare, only by the latter. The luxation may be complete, the tibia being carried altogether in front or behind the femur, and forced some distance up the thigh; or more often incomplete, and the bones still to a great extent in contact. The ligaments are always torn, or wrench away portions of the bones; the neighboring tendons and muscles, such as the hamstrings and the gastrocnemius, are lacerated or stretched; and the vessels either compressed, so that the circulation is stopped or actually torn across. The shape of the bones is easily made out, and the nature of the injury can hardly be mistaken. In the forward dislocation the limb is usually extended, and if it is complete, much shortened. The patella is freely movable; sometimes the joint is fixed; sometimes, owing to the extent of the laceration and the position of the bones, there is a wide range of passive movement. In the backward form the displacement is more variable; generally the limb is in a position of extreme extension, but it may be completely flexed.

Reduction, especially under an anæsthetic, is easy, and may be accomplished either by traction in the axis of the limb, or by flexion and extension, according to the position of the bones. The condition of the vessels below should be ascertained at once; even if the artery has only been compressed or stretched, a thrombus may form, and gangrene set in; or later an aneurysm may develop; if it has given way, immediate amputation should be performed. Usually this is required in compound dislocations; only, perhaps, sometimes, when the skin is not so much torn, and the vessels are intact, and the patient is young and healthy, an attempt may be made to save the limb, either by washing the joint out and draining it thoroughly, or by performing a primary excision.

## Dislocation of the Semilunar Cartilages.

In this accident, which was first described by Hey under the name of *internal derangement of the knee joint*, one of the semilunar cartilages is displaced and caught between the bones, so that the joint is locked and, so far as the patient is concerned, is entirely out of control.

The external cartilage glides backward and forward freely over the upper surface of the tuberosity; the internal is more fixed and follows the movements of the tibia; but the latter appears to be the more frequently displaced. The nature of the injury probably differs a good deal. Sometimes the margin of the cartilage is detached, and the disc is rolled inward toward the centre of the joint; the external has been found by Godlee rolled up in the inter-condyloid notch. More often one of the ends is torn away from the bone, and the disc is squeezed out under the skin, either in front or to one side. The anterior part of the internal is

the part that gives way the most frequently; and it has been found, as the r of football, so completely detached that it had to be removed as a foreign b In many instances it is probable that the actual laceration is insignificant, fibrous tissue by which they are attached being stretched, rather than torn that in certain positions of the joint the cartilages can be pushed backwar forward until they are caught between the bones. Such an accident may oc even in a healthy joint; but it is much more likely to happen when the ligam are already relaxed by chronic synovitis or rheumatoid arthritis; and, for reason, recurrence of the displacement, when once it has occurred, is the r rather than the exception. The joint always becomes filled with fluid after t accident; the ends of the cartilage, if it is torn, are forced apart from each oth so that repair can only be carried out imperfectly, and all the ligaments a stretched and softened. For the same reason internal derangement is not uncom mon in young, rapidly-growing subjects, in whom, owing to the weakness of t muscles and the poor development of the articular ends, the bones can often b made to assume abnormal positions; but it may happen to the strongest and mo athletic.

The cause is always a trivial one; crossing the legs, for example, while seated; catching the inner side of the great toe in walking; twisting round to take a ba at lawn-tennis; or even suddenly turning over in bed. Nearly always it is caused by rotation while the leg is semi-flexed; in eversion the internal one suffers; in inversion, the external; it may occur, however, at the end of extension, if there is no weight on the limb to hold the bones together. Thus it is common at football when a kick is missed; the posterior end of the internal cartilage is carried for ward until it slips under the condyle; if it slips back again, there is merely a sharp stab of pain, often followed by a slight amount of effusion; but, if it is caught there is genuine displacement and the limb becomes locked. Knott's and some of Hey's cases were probably similar. In Lucas's the external was displaced, th posterior end being carried forward in the same way until it was caught under th condyle; there was a sudden jerk when the joint was flexed; a projection made i appearance on the outer side of the patella and the limb became inverted; in ex tension this was reversed, the limb becoming straight and the projection vanish ing. Several similar instances have been recorded by Marsh.

It is not uncommon to find, after repeated accidents of this kind, that there is a certain amount of permanent thickening, generally on the inner side of th limb; and in one or two cases the disc appears to have become hypertrophied from the effect of constant irritation. According to Kocher it may become con verted into a mass of granulation tissue, and, unless it is excised, lead to suppura tion in the joint.

**Symptoms.**—In all the cases there is a strong family likeness, though there are many small points of difference, depending in all probability on the charact and the direction of the displacement. There is a sudden attack of the most in tense pain; the patient falls down almost in a fainting condition with the kn slightly bent; and in severe cases he is quite unable to stand. Voluntary mov ment is out of the question, but passive motion is free and almost painless; if th patient sits on a table he can swing the leg backward and forward, but not to i full extent in either direction. In a few minutes the joint becomes filled wi fluid; by degrees the severity of the pain abates, and very slowly power retur until the patient can limp about; but so long as the displacement persists, f flexion and extension are impossible. Sometimes a projection can be seen on outer or the inner side of the limb, corresponding to one of the cartilages; occ sionally the skin is puckered in when the displacement is toward the interior; most instances the only change visible is a slight relaxation of the ligament patellæ when compared with the opposite side. Synovitis is invariable and as rule very rapid.

Slighter cases, in which the cartilage probably slips back of itself, are n uncommon. The patient generally complains of the joints locking or catc

a moment's sudden pain, and then, after a sensation of something slipping y, of being able to move again, but with a certain degree of uneasiness.

**Diagnosis.**—The history and symptoms closely resemble those of loose cartges in a joint, but the presence of a projection or a depression on a level with head of the tibia, and the continual locking of the joint, generally make the gnosis certain. If, however, before the case is seen the synovial cavity has ady become distended, the difficulty may be very considerable, and in all s in which the history or symptoms suggest either of these conditions, it is visable to make the most thorough examination, not only at once, but afterward en the effusion has in great measure subsided. Much discredit has arisen on ore than one occasion, from the fact that this displacement has never been recognized.

**Treatment.**—The first thing is to release the cartilage. In the slighter cases it often slips back of itself before the patient is seen, or is reduced by some almost involuntary action. Knott, for example, relates how, on the first occasion on which it happened to himself, he instinctively applied his hands upon each side of the joint and pressed as firmly as he could to relieve the pain ; suddenly he felt something slip and the limb could be moved again at once. Where the displacement has repeatedly occurred this is frequently the case and the patients learn either to do it for themselves or to direct others in the manipulation required. An anæsthetic is not absolutely needed, but in most cases it is advisable ; the manipulation is so much more easy, and the condition of the joint can be examined so much more thoroughly.

Hey recommended that the patient should be seated on a high chair facing the surgeon, who should grasp the limb firmly, extend it, until it was as straight as circumstances would allow, and then rapidly flex it. Modern surgeons have reversed this proceeding with advantage, as preliminary extension is much more painful than flexion, and in the second step rapid flexion is somewhat difficult to carry out. Whichever plan is adopted, firm pressure must be made with the thumb over any projection that can be felt. If this fails the limb may be flexed to its full extent, rotated inward or outward as far as it can be, and then rapidly extended, or abduction and adduction may be tried in the same way. Sometimes it suddenly slips into position almost of itself ; in a few cases it has never been reduced at all, although repeated attempts have been made, not only at first, but afterward, when the effusion into the joint had been absorbed. In such cases, or if the displacement takes place so frequently that the joint is practically useless, and is in serious danger of becoming disorganized from repeated attacks of synovitis, there is no doubt the cartilage should either be removed, or be reduced and stitched into position with catgut.

As soon as reduction has been accomplished, means must be taken to get rid of the effusion. Recurrence cannot always be prevented, especially if one end of the cartilage has been torn off the bone ; but there is no doubt the tendency to it is greatly increased by the amount and persistence of the effusion. The limb must be carefully packed in cotton-wool and bandaged as firmly as possible ; and if the pain and tension are very severe, it should be placed upon a splint and the patient kept in the recumbent position for a few days. Passive motion may be commenced after forty-eight hours, so that there may be no after-stiffness or wasting of the muscles ; but the extremes of flexion and extension should be avoided, and care should be taken to keep the foot perfectly straight.

After the effusion has been absorbed an apparatus must be worn for some months, especially when indulging in any exertion which, like lawn-tennis, has a particular tendency to produce this displacement. If it has happened only once, n elastic knee-cap, strengthened and padded opposite the cartilage, whichever it s, may suffice, but this must only be worn during exercise, never at night ; and he knee, every time it is removed, must be thoroughly rubbed and shampooed, r more harm than good may result. In older cases this is not enough, and a etal apparatus must be fitted on. A very good arrangement consists of two

well-padded metal plates, accurately fitted round the knee-cap, one on either s and held together above and below by short straps. These plates are connec together by a steel spring passing horizontally across behind the joint, so t when the splint is in position they press firmly upon the unprotected portion the capsule where the displacement is most likely to take place. If this does n answer, or if, as not unfrequently happens when the internal lateral ligament the knee joint has been injured, rotation of the tibia is a marked feature in t displacement, the best kind of apparatus is formed on the principle of two lat bars, jointed opposite the knee and connected together above and below b circle round the limb, formed partly of metal, partly of leather. An additio strap across the joint above and below the patella is of service. This is heav and more cumbersome, but much more efficient than the former in checki irregular movements of rotation. In any case the patient should learn to ke the foot as constantly as possible turned in the direction of the displacement inverted, that is to say, when the internal cartilage is affected, and *vice versâ*.

## DISLOCATION OF THE ANKLE.

The foot may be detached from the tibia and fibula, and driven either back ward, forward, inward, or outward; but the displacement is rarely complete. A few cases are recorded in which the bones of the leg have been separated from each other, and the astragalus driven up between them.

### Lateral Dislocation.

This is caused by the foot being forcibly twisted on an antero-posterior axis, and it can scarcely take place without fracture of one or both malleoli.

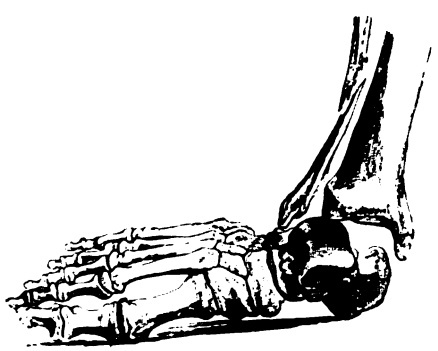


Fig. 233.—Pott's Fracture.

Dislocation outward, with fracture of the fibula, is the more common, and is known as Pott's fracture (Fig. 233): the foot is forcibly everted, the strain falls upon the internal lateral ligament or the internal malleolus; one or other of them gives way, the fibula breaks inward toward the tibia a short distance above the joint, and, if the force continues, the astragalus is twisted round in its socket, carrying with it the bones of the foot. When the violence is very great, there is, in addition, a vertical fracture through the tibia, a portion of the bone being dragged away by the interosseous ligament. If the separation is only slight, the deformity is not serious, though, unless care is taken to prevent it, the socket in which the astragalus is fixed may be widened, and the security of the joint permanently impaired; but, if it is extensive, the whole of the foot and the external malleolus may be carried upward on to the outer side of the leg, until the articular surfaces are completely displaced. This, which is known as Dupuytren's fracture, is very rare but very serious.

It sometimes happens, when both malleoli have given way, that the astragalus, with the foot, is carried boldly outward or inward on the leg without any twisting.

Dislocation inward is not so often met with. It can only be produced by extreme inversion; the internal malleolus or the portion of the tibia carrying it

**[d]rized off by the rotation of the foot, and either the external lateral ligament is [to]rn, or, more commonly, the fibula is broken outward, from the traction upon its [in]ferior extremity. Sometimes the astragalus itself is crushed as well.**

### Antero-posterior Dislocation.

In spite of the width of the astragalus in front, and the strength of the [la]teral ligaments, the foot is occasionally displaced backward; displacement [for]ward is very rare. In either case the lateral ligaments give way; or the fibula, [or] the internal malleolus, is broken off instead, and [the] foot carried forward or backward with the bones of the [fo]ot.

Fig. 234.—Dislocation of Foot, Backward.

Dislocation backward may be either complete or incomplete (Fig. 234). It is caused by forced plantar flexion, the point of the foot being depressed until either the bones or the anterior part of the lateral ligaments give way; then if any force is applied to the leg from behind (such, for example, as the impetus of the body in falling from a carriage in motion) the tibia and fibula are driven over the front of the astragalus. As soon as the force is spent, the foot is straightened by the action of the muscles.

Forward displacement may be produced by extreme dorsal flexion: if, for example, while the foot is fixed and the knee and ankle are completely bent, a violent blow is delivered on the front of the thigh, driving the bones of the leg backward; but only six cases are on record.

In *dislocation upward* the fibula is wrenched off from the tibia, the interosseous ligament either giving way or tearing off a portion of the bone; the lateral ligaments are torn, and the astragalus is forced vertically upward into the inter-space. This can only arise from an extreme degree of violence applied to the sole of the foot, the bones first being separated and then the astragalus driven upward by a continuance of the force. In one case it was bilateral, caused by jumping down from some great height.

**Diagnosis.**—Immediately after the accident, there is rarely any difficulty, owing to the way in which the bony prominences stand out beneath the skin; but the outlines soon become fainter as the depressions are filled up by the extravasation and swelling, and, in a little while, nothing can be seen but general distortion. The position of the foot with regard to the rest of the limb, whether it is inverted or everted, shortened or lengthened, always gives a clue to the nature of the injury; and then deep pressure may be used to determine the particular character of the displacement and the amount of damage done to the bones and ligaments, every bony projection being compared, one by one, with the corresponding ones in the opposite foot. Finally, passive motion must be tried, not only to assist in identifying the bones by the way in which they move, but to ascertain the presence of abnormal mobility (lateral flexion, for example), or of crepitus.

**Treatment.**—The method of reduction is essentially the same in them all. The patient must be placed under an anæsthetic, to relax the muscles; the knee must be flexed, and then the foot must be slowly but firmly brought round to its right position. If the displacement is lateral, this is generally easy; when it is backward, it may usually be managed by extreme plantar flexion, drawing the foot downward, away from the leg, at the same time, and rocking it from side to side so as to disentangle it; but in dislocation of the foot forward the difficulty is very great. Dorsal flexion appears to offer the best prospect, and the tendo-

Achillis or any other that gets in the way between the bones, may be divi but even then the attempt has not always been successful.

Upward dislocation, the diagnosis of which is easy, from the enor breadth of the lower part of the leg and the approximation of the sole of malleoli, can only be reduced by extension on the foot. If the attempt fails, limb ultimately becomes very useful, although the joint itself always remains

In all dislocations of the ankle, some form of apparatus is required after duction has been accomplished, to prevent the surfaces being displaced ag In the slighter cases, in which the tendency to return is not very marked, and injury is seen a short time after the accident, so that the extravasation is not treme or the skin in danger of giving way, a fixed apparatus may be applied once, only it must be formed in two parts, laced, or fastened together in so other way; and it must be thickly padded with cotton-wool opposite the seat injury. Afterward the limb must be raised for twenty-four hours, and the kn joint kept flexed until the tendency to spasmodic contraction on the part of th muscles has disappeared. Passive motion and massage may be commenced at th end of ten days, but the limb in the meantime must be incased in a starc bandage, and the patient must not be allowed to rest any weight upon it for a least six weeks. The greatest care is necessary during the whole course of trea ment to prevent any drooping of the toes or version of the foot. If either these is present, the limb becomes almost useless.

When the injury is more severe, and in all cases of antero-posterior displac ment, it is better to make use either of back and side splints, swinging the l from a cradle (as already described in speaking of fractures), or of a single si splint with a foot and sole piece, the limb resting upon its outer surface. either case the knee must be kept well bent, the foot must be exactly at ri angles to the leg, and the pads must be so arranged on the splints as to correct far as possible any tendency to eversion or inversion. If a side splint is used, it of great advantage to pack the ankle well with several layers of cotton-wool a bandage it firmly over all. Very often, unless this is done, it is difficult to certain whether the displacement is rectified or not, owing to the amount a the persistence of the œdema and extravasation. The limb may be placed i fixed apparatus at the end of a fortnight, but this must be so arranged that it be removed for the purpose of carrying out passive exercise every two or th days. If this is neglected, the joint is liable to become exceedingly stiff a painful.

*Compound* (*open*) *dislocation of the ankle-joint* is a most serious injury, a especially if the patient is broken down in health, may require immedi amputation. Age is not of so much importance in this respect as the conditi of the kidneys, though of course the risk increases with advancing years. Mu depends upon the way in which the accident happens. If it is the result of direct violence, so that the skin on one side of the joint is torn, and t interior exposed, without the bones being crushed or the soft parts bruised, t limb may be saved, though it can only be done by the most perfect drainag Even if suppuration and ankylosis occur, it may prove exceedingly useful, t mid-tarsal joint replacing the one that is lost. The bleeding must be stoppe detached fragments of bone or cartilage removed; the wound thoroughly wash out (it is a very good plan to immerse the part bodily in a corrosive sublim bath for some hours) and so arranged that it can drain perfectly, counter-op ings being made, if need be, to ensure this. If the wound is very small, it be sealed and closed at once; as a rule, it is better to leave it open, so that cavity can be constantly washed out and there may be no accumulation in interior. Then the ankle must be covered with a thoroughly absorbent dres and fixed upon a splint, interrupted so that the wound may be exposed with disturbing the bandages. Paraffin is very useful for this, as it is waterproof.

In many cases the wound heals up at once; sometimes there is a cer

amount of discharge; granulations spring up round the orifice, the synovial lining becomes unduly thickened and vascular, and the joint is stiffened from the formation of extra-articular adhesions; but the cartilages remain intact and the cavity is preserved. If, however, the drainage is not perfect, or if the discharge is allowed to decompose inside, acute suppurative arthritis is sure to set in; the cartilages necrose; the ligaments are destroyed; the surface of the bones becomes carious; and abscesses form in the loose cellular tissue around. Even then, if free exit is provided, and the cavity is kept constantly clear, granulations may spring up and fill the cavity, until the opposite surfaces fuse together; but secondary amputation may at any moment become necessary. The patient's health and strength may fail from the intensity of the fever and the profuse suppuration; or the inflammation may spread along the tendon-sheaths or the planes of cellular tissue; or the bones may become extensively necrosed; and finally, even when ankylosis has set in, it may be required, owing to the useless condition of the limb.

When the injury is more severe, the same general plan of treatment may be followed; but if it is the result of direct violence the prospect of success is very small. The tendons may be sutured; the ends of the bones resected (removal of one malleolus has some advantage, as it gives more room for drainage), and even the posterior tibial has been divided and tied, with a good result; but if the skin is badly bruised and stripped off the adjacent tissues, or if it is torn a considerable way round the limb, recovery with a useful foot is almost hopeless.

### Dislocation of the Astragalus.

This must be distinguished, on the one hand, from dislocation at the ankle-joint, in which the whole foot is detached from the leg; and, on the other, from the subastragalar form, in which the rest of the tarsus is separated from the astragalus. In this injury the astragalus is dislocated both from the foot and from the leg; and is thrown out from its socket, sometimes so thoroughly that it has been shot out of the foot altogether.

The displacement may be either forward or backward, the bone generally being forced to one side or the other at the same time. True lateral displacement without fracture of the malleoli is scarcely possible; most of the instances, in all probability, having been really dislocations forward first. In a few very rare cases the astragalus has undergone a process of version without leaving its bed; the bone has been twisted round in its socket by some violent wrench, so that the lateral surfaces look upward or downward, or its head faces one of the malleoli.

*Dislocation forward* is produced by over-extension; the foot is first detached from the astragalus; the head of this bone is twisted out from the scaphoid; and then, if the force continues, the lateral ligaments give way, and it is shot out from underneath the tibia. As soon as the force is spent the muscles pull the foot into position again. The dislocation may be either complete or incomplete; the astragalus, that is to say, may be forced altogether out of its socket, until it rests either on the cuboid, or on the scaphoid and cuneiform bones, according to the side, while the tibia rests upon the os calcis; or it may be merely detached from its connection, and lie still partly under the bones of the leg (Fig. 235). In either case the neck of the bone is not unfrequently broken.

The prominence caused by the peculiar shape of the bone can be recognized at once; the foot is turned inward or outward, in the opposite direction to the displacement; the sole, especially in the complete form, is brought nearer to the leg; one malleolus stands out while the other is deeply sunken; and all movement is abolished.

*Dislocation backward* is much more rare, and, owing to the space in front of the tendo-Achillis, is not so conspicuous. It can only be produced by extreme

flexion; in one instance, for example, the foot was fixed, the heel driven down into a depression, and the leg crushed down upon the foot. In most it is incomplete, and generally it is rather to one side, but it may be nearly straight. The foot is neither inverted nor everted; in front there is a depression over which the edge of the tibia can be felt, and the great toe is strongly flexed, owing to the tension on the tendon of the flexor longus pollicis; behind, the tendo-Achillis is forced back, a hardness can be felt in front of it, and in some cases, where the displacement is lateral, the shape of the bone can be made out to one side or the other.

**Treatment.**—In the incomplete form of dislocation forward (which is the most common) reduction may be accomplished by placing the patient under an anæsthetic, bending the knee, and making traction on the foot away from the leg while in the position of plantar flexion, direct pressure meantime being exerted on the anterior surface of the bone. If this fails the tendo-Achillis may be divided, and any other bands that are plainly in the way; but, especially if the dislocation is complete, the attempt is very likely to fail. The space between the

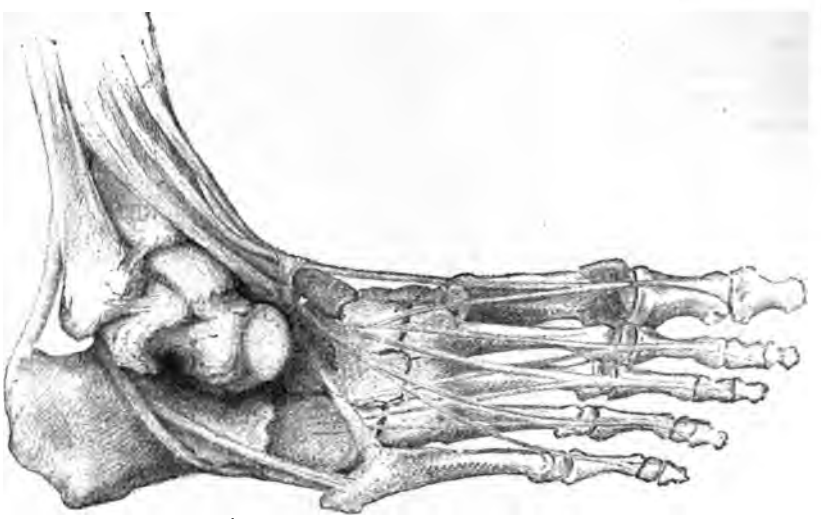


FIG. 235.—Subastragalar Dislocation, with Partial Luxation of Astragalus from Leg.

bones is so much reduced; the astragalus itself is often twisted; there is very little hold; and sometimes the bone is so caught and entangled that it cannot be released.

If it does fail, the astragalus should be left *in situ;* the foot, especially when the dislocation is backward, regains a wonderful amount of power. Subsequently, if the skin over it sloughs, or if it is seriously in the way, it may be excised. The operation should not be performed at once, as the parts are so badly bruised that suppuration would almost certainly occur.

In compound dislocations, if the skin and the vessels are not much injured, the astragalus may be freed from its remaining attachments and excised; but in many cases amputation is necessary.

### SUBASTRAGALAR DISLOCATION.

This is produced in the same way as the former, but by a less degree of force; the bones of the tarsus only are separated from the astragalus; this is often partially displaced from under the tibial arch, but is not dislocated from

Dislocations forward, and to one side, have been described, but the displacement is nearly always backward, with a certain amount of lateral deviation. It is generally complete so far as the scaphoid is concerned, but it is seldom that the astragalus is entirely detached from the os calcis. The foot is in the position of plantar flexion, everted or inverted, in the direction of the displacement, and carried backward. The head of the astragalus forms a rounded projection on the dorsum under the skin; one malleolus is prominent, the other buried; but they still retain their relation to the astragalus; there is no shortening, as in the former dislocation, and a certain amount of movement is permitted at the ankle-joint itself.

Reduction may be accomplished by drawing the foot forward, while in extreme plantar flexion, and pressing from behind upon the heel. If this does not succeed, any tendon that is clearly in the way may be divided, and a further attempt made; but not unfrequently it fails, either because the under surface of the astragalus is caught against the groove of the os calcis or the dorsum of the scaphoid, or because the neck of the bone is entangled in the tibial tendons.

Dislocations of the other tarsal bones are very rare; the internal cuneiform and the scaphoid have been displaced separately, and the scaphoid and cuboid, carrying with them the anterior part of the foot, together. There are more instances known in which the metatarsus has been dislocated from the tarsus; sometimes all the bones together (in one case carrying with them the internal cuneiform); more often separately or in groups of two or three.

Dislocation of the toes, both at the metatarsal and phalangeal articulations, are not uncommon; in the case of the great toe the same difficulty occurs as that already described in the thumb, probably for the same reason.

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## SECTION V.—DISEASES OF JOINTS.

Inflammation of a joint nearly always begins in the most vascular part, that is to say, either the synovial membrane or the growing portion of the bone, and spreads from there to the rest of the tissues. Osteo-arthritis is an exception; whether it is acute or chronic, inflammatory or degenerative, it is general from the first, and affects all the structures, though not always to the same extent.

### Pathology.

1. *The Synovial Membrane and the Capsule.*—The immediate effect is the same, whether the inflammation begins in the cavity or extends into it from the bones or other structures near.

The vessels dilate; the amount of blood flowing through the part increases; lymph is poured out in excess; the cellular tissue becomes soft and spongy; the interstitial spaces are enlarged and filled with exudation; the endothelium is detached; and the interior loses its polished appearance, and becomes rough, velvety, and granular. In severe cases stasis and extravasations of blood occur as well. This is most marked where the tissues are soft and vascular; the fibrous capsule at first is scarcely affected; on the other hand, the folds at the margins of the joint, and the pads of loose cellular tissue and fat which fill up the inequalities between the bones as the position of the limb changes, become more and more swollen, until the whole available space is occupied.

The exudation collects in the synovial cavity even more freely than it does

in the tissues. The amount of fluid is increased; the peculiar character of the synovia is lost; and the joint is filled with a turbid and blood-stained fluid, mixed with detached endothelial cells, flakes of fibrin, small blood-clots, and masses of lymph-corpuscles.

The ligaments and the capsule, owing to the density of their structure and the scanty distribution of vessels, for a long time show but little change. If, however, the inflammation continues, at length they share the same fate. The hyperæmia begins to show itself; the fibres soften; the interfibrillar substance becomes more abundant and more fluid; the exudation increases in amount; new vessels grow in from around; and by degrees the natural structure is replaced by a mass of soft vascular granulation tissue, in which a few traces of the original bundles of fibres can be found here and there, more or less softened.

The subsequent changes depend upon the nature and persistence of the cause.

If it ceases to act, resolution begins, the hyperæmia disappears, the exudation is absorbed, and the fibrous tissue becomes firm again.

If it continues, the effect depends whether it is (*a*) merely a mechanical or chemical irritant or (*b*) a living organism.

(*a*) In the first case the synovial membrane may continue to pour out an enormous quantity of a clear watery fluid (*hydrops articuli*); or a kind of false membrane may form upon the inner surface (*fibrinous synovitis*); or the secretion may grow thicker and thicker until, without there being any destruction of the cartilages, or suppuration outside the joint, the interior is filled with a fluid apparently similar to pus (*purulent synovitis*); or (especially when it is due to rheumatism) organization may be the prominent feature, the synovial lining becoming thickened and opaque, the soft tissues condensed and hard, and the interior covered with outgrowths, synovial folds, and fringes, sometimes uniform in shape and size, and springing from every part of the sac (*papillary synovitis*) (Fig. 243), sometimes few in number and very large.

(*b*) In the second, when the irritant is a living organism, the effect depends upon its mode of action. In tubercle, for example, the synovial membrane and the structures around are converted into a mass of granulation tissue, which slowly undergoes caseation and liquefaction; in syphilis, gummata form; and when the micrococci of suppuration enter, all the tissues melt away and form pus; the whole joint is converted into an abscess, and, unless the tension is relieved at once, even the cartilage and the bone perish.

2. *The Bone and Cartilage.*—(*a*) If the irritant is a very intense one, the bone and cartilage, like other dense and almost non-vascular structures, simply undergo necrosis. Sometimes the sequestra are wedge-shaped (Fig. 252), with their base toward the joint and covered with cartilage, as if caused by embolism. A mass of some material (caseous and full of bacilli if it is tubercular; broken down blood-clot with micrococci in pyæmia) is carried along by the blood-stream until it is impacted in one of the small arteries at the cancellous end of a long bone; and the corresponding area of tissue perishes, partly from the blood-supply being cut off, partly from the inflammation caused by the embolus. Sometimes, on the other hand, when the attack starts from the synovial cavity, the surface is the first part to feel the effect, and either the whole of the cartilage is separated from the bone beneath (Fig. 238), or, more frequently, only those parts upon which the pressure falls, where, for example, the patella and the upper surface of the tibia are in contact with the condyles of the femur. When this occurs the articular lamella of the bone usually comes away as well, leaving the cancellous tissue beneath exposed and carious.

(*b*) If the exciting cause is not sufficiently intense to cause necrosis, the bone and cartilage undergo the same changes as the other tissues, only more slowly and with certain peculiarities of their own.

In the bone the inflammation begins as rarefying osteitis; the cancellous tissue becomes softer and more vascular; the trabeculæ are absorbed; and the cancelli filled with inflammatory exudation. What happens next depends upon the exci

cause. Resolution takes place in a large proportion of cases. Of the rest, some the exudation simply continues to spread (fungating caries), without undergoing any further change, until it invades the articular lamella (Fig. 251), and either detaches the cartilage from beneath or perforates it; in others it breaks down into pus, and bursts through everything into the synovial cavity; and in others again it undergoes organization and leads to sclerosis and condensation (Fig. 242).

The effect on the cartilage is very similar. The matrix becomes softened (in osteo-arthritis it splits up into fibrils arranged vertically to the surface (Fig. 239), the plasmatic canals dilate so as to allow the entry of a larger quantity of lymph, and the corpuscles increase in number. In the centre, where there is pressure, the inflamed cartilage becomes absorbed; around the margins it becomes vascular, the blood-vessels growing into it from the synovial membrane, so that it is either gradually replaced by granulation tissue, as in tubercular disease, or is heaped up into thickened and hypertrophied lips, as in osteo-arthritis. So slowly, however, does this take place that, in many forms of joint disease, the cartilage is removed by simple atrophy and fatty degeneration, or by the erosion of granulations that spring from the opposite bone or the surrounding tissues. In the former case the whole covering of cartilage is thinned, the surface is smooth and rounded for the most part, but marked here and there with broad flat depressions, where the pressure of the opposing surface has caused absorption to progress more rapidly, and the microscopic character is unaltered except for the presence of fatty molecules in some of the corpuscles. In the latter it is eaten out all over into little circular pits, some quite superficial, others so deep that the bone beneath is exposed (Fig. 236).

FIG. 236.—Lower End of Femur of an Infant, from a case of suppurative arthritis, showing the way in which the cartilage is eaten out in little circular pits, some penetrating down to the bone.

## ETIOLOGY.

Inflammation of joints may be primary, originating in the synovial lining or some other component part; or consecutive, due to extension from a focus of disease in other structures near.

1. *Primary inflammation* is due either to the persistent action of a mechanical or chemical irritant, or to a living organism.

(*a*) *Mechanical Injury.*—A single strain merely causes a certain degree of damage, which, if the tissues are healthy, is repaired forthwith. If, however, it is repeated, or if before its effects have died away a second irritation of any description makes its appearance, nutrition is impaired and inflammation follows. Thus a neglected loose cartilage gives rise to synovitis and ultimately arthritis; and want of rest or undue tension may cause an acute attack after a simple sprain.

(*b*) *Chemical Irritants.*—In gouty synovitis urate of soda is always present in the fluid and sometimes in the tissues. It may be itself the exciting cause; but, as it is not unusual to find a considerable deposit in joints that have never shown a sign of inflammation, it may, on the other hand, merely be an evidence that the vitality of the tissues is impaired, so that they are unable to withstand the slightest irritation. Of all chemical poisons the most intense is that produced by septic decomposition, breaking out in a foul and ill-drained wound.

(*c*) *Living Organisms.*—These may be pyogenic or specific. In either case the irritated tissues around strive to protect themselves and repair the injury by throwing out masses of lymph; in the former (acute suppurative arthritis) this melts away as pus, the fully developed tissues perishing, too, so long as the germs are the stronger; in the latter either caseation and liquefaction set in (tubercle) or absorption and organization (syphilis).

In addition to these there are, as in the case of osteitis, other agencies which perhaps, should rather be regarded as predisposing than exciting causes. Of these the most important are the action of cold and damp and the influence of the central nervous system.

(*a*) Exposure to cold and damp may be followed either by acute inflammation (the resisting power of the tissues is so depressed that the least irritation is sufficient to cause a very severe attack); or when, without being intense at any one time, they exercise their influence for years together, by a kind of degeneration or very chronic inflammation, characterized by changes similar to those that occur in old age after prolonged disuse, but more severe.

(*b*) *Diseases of the Nervous System.*—It is believed by many that certain very rapid forms of degeneration, attended with more or less inflammation, may be caused by diseases of the central nervous system or the peripheral nerves. The pathological changes belong to the same class as those that follow prolonged exposure to cold and damp and other depressing agencies, though they present certain differences in degree; the clinical symptoms, however, in most cases enable a distinction to be drawn at once.

How causes of this kind act is uncertain. It must be admitted, if they are merely predisposing ones, their influence is so strong that an almost imperceptible irritant is able to produce an entirely disproportionate result. All that can be said is that the impairment of nutrition, known as inflammation, may be induced either by continued irritation (mechanical or otherwise); or by a depressed condition of vital energy, general or local (exposure to cold and wet, and certain affections of the nervous system); or with much greater effect by both together.

2. *Consecutive inflammation* may extend into the joint from any of the tissues near; the bones the most frequently, the bursæ, tendon sheaths, and cellular tissue less often. So long as the original focus of disease is at some distance, whatever its character may be, whether it is traumatic, tubercular, or suppurative, only the synovial membrane shows any effect, and the inflammation is not specific. A tubercular focus, for example, in the end of one of the long bones merely causes synovitis so long as the bacilli are limited to the bone; and after evacuation of the caseous focus (if it can be cleared out without involving the joint), the secondary affection disappears of itself; but, if left, the micro-organisms are almost sure to work their way in at last, and then the inflammation of the joint becomes tubercular and specific. The same is true of the pyogenic and probably of all other organisms; simple inflammation precedes the specific and prepares the way for it.

### Mode of Examination.

Examination in a case of suspected joint disease must be systematic and thorough, conducted with a definite object, taking care not to alarm the patient, and putting off to the last everything that might give pain. Children in particular are nervous and often exceedingly afraid of being hurt, and an incautious movement at the first may throw all the muscles around the articulation into a state of perfect rigidity, and obscure some of the most valuable signs. Unless it is wished to explore sinuses with a probe, or to ascertain the existence or the extent of fibrous adhesions, an anæsthetic is inadmissible, as many of the most important symptoms depend upon contraction of the muscles, which, of course, disappears at once.

The *history*, family as well as personal, and any evidence of a constitutional diathesis that may be present, must be carefully noted, and then the patient's own account of the commencement of the disease, the supposed cause, the time of its first appearance, the progress it has made, the kind, severity, and locality of the pain, and whether it is made worse by any particular movement. In the case of the lower extremity, if the inflammation is not acute, the amount of impairment can be fairly well estimated by seeing the patient walk.

It is an absolute rule that the two sides of the body must be compared together under the same conditions.

*nspection* and *measurement* come first. If it is the hip joint, the patient l lie upon a firm couch with the legs parallel and the knees extended; for oulders he should be seated facing the light. The condition of the skin, er it is reddened or not, the shape of the joint, the presence of any enlarge- the wasting of the limb, or of one particular muscle, and any malposition— tion or adduction, flexion or displacement—can be detected at once. The lty is greatest in the case of the hip, as by arching the back and tilting the ; an appearance of parallelism and extension is produced, while the reality y different. These results can then be verified by measurement. The rod d be used to ascertain any alteration in length, a tape to take the circumfer- and callipers, or the hand, which after a little practice can appreciate the minute change, to make certain as to the difference in shape.

Further information may be obtained by *touch*, proceeding very carefully at as sometimes there is great tenderness on pressure. The enlargement may be and firm, like the bone upon which it rests; or soft and fluctuating if it is o an effusion of fluid; or it may have a peculiar elastic resistance, as when ynovial membrane and the tissues around are converted into a pulpy gela- s mass; or it may vary very greatly in consistence, especially if suppuration ccurred and the pus is working its way near the surface. The *temperature* be ascertained in the same way with great exactness, taking care always to are identical spots on the two limbs; the loss of muscular tone can be felt, when no wasting can be detected with the eye; and the finger often finds out some parts of the skin are usually tender or œdematous.

Finally, when all this is clear, an attempt may be made to ascertain the *range vement*, whether it is limited in any direction or attended with pain; if there y grating, as of two bony surfaces rubbing against each other, or crepitation, en the cartilages have lost their polish and the synovial fringes are enlarged ardened; and whether there is any abnormal mobility and displacement or cation of the ends of the bones. Greater care than ever must be taken in tigating this, as the least rough movement, or even sometimes the approach e hand, scares the muscles into activity, so that the joint is held perfectly

Such tests as jarring the heel or the knee in hip disease, which depend solely the pain they cause, should never be employed, unless from other evidence practically certain that the joint is not inflamed.

## INFLAMMATION OF THE SYNOVIAL LINING.

### 1. Simple Acute Synovitis.

n most cases synovitis is merely a symptom of arthritis: and whatever the unless the attack subsides at once, the inflammation is never really restricted e lining membrane. Still, for the sake of convenience, and because the es, although they are not absolutely confined to that structure, are very much extensively shown by it than they are by the rest, it is usual to describe some at least as if the affection were a distinct one.

**Causes.**—These may be local or constitutional. Injury, extension from the or from some other structure near, or cold and wet, may cause it; or, on the hand, it may be merely a sign of some constitutional ailment, such as gout eumatism. These varieties, however, as they are specific, must be described emselves.

The *pathological appearances* of simple synovitis have been described already. oint is distended with fluid, the endothelial lining is detached, the interior is ened and has lost its polish, all the folds are bright red or purple with extrava- s, and so swollen that they overlap the margins of the cartilages; and all ose tissues round are softened, thickened, and filled with lymph. The fluid

varies much in character. In cases of injury in which the hemorrhage is often considerable and the swelling immediate, it may be almost pure blood (*hæmarthrosis*); more often it is a mixture of synovia, blood, and lymph in varying proportions. It many cases it is thin and watery, as if it were mixed with serum; not unfrequently, when the inflammation is severe and the tension high, the number of leucocytes and the amount of fibrin increase to such an extent that it becomes milky and even purulent. This is known as *catarrhal suppuration;* it may occur after injury, but it is much more common when, as in urethral rheumatism, the irritant is of greater intensity without being so severe as to cause suppuration. The distinguishing feature between it and true suppurative synovitis is the preservation of the synovial membrane; the secretion comes merely from the surface and does not involve the deeper strata.

**Symptoms.**—The *position* of the limb is characteristic. The affected joint is fixed rigidly by the muscles in the position of greatest ease. The hip is flexed, abducted, and everted, the knee held at an angle of 140°, the ankle slightly extended, the arm hangs by the side, and the elbow and wrist are somewhat bent. As a rule, the patient can flex the limb further still, but complete extension is out of the question. Not only does it diminish the capacity of the sac and increase the pressure upon its inner surface, but, by the traction it exerts upon some parts of the inflamed and tender capsule, it makes the pain tenfold worse. Later, when arthritis sets in, and the bone and cartilage are involved, this position is exaggerated, and more serious displacement caused by the persistent contraction of the flexor muscles.

*The shape* assumed by the distended synovial sac is equally important. In acute traumatic synovitis it is often filled to its utmost, but the general outline is scarcely altered; there is little or no œdema of the cellular tissue around, as in some forms of inflammation, and the weaker parts have not had time to yield and stretch, as when the attack is more chronic.

In *the knee* the patella is pushed forward; the depressions on either side of it, extending down by the ligamentum patellæ, are filled up, so that the front of the joint is evenly convex; and the pouch under the quadriceps is distended, though it is not stretched upward as in chronic synovitis. Fluctuation can be distinctly felt on either side of the knee-cap, the hands being placed across the joint, one above and one below, so that the synovial pouch is grasped between the fingers and the thumbs; and the patella itself can be made to float. This is the most valuable sign of all. If the synovial sac is full there is no difficulty; the limb must be gently extended and supported so as to relax the quadriceps, and then the bone can be pressed back at once against the articular surface of the femur. More care is required if the distention is only moderate; the upper part of the sac above the patella must be emptied by squeezing the fluid out of it into the lower space; and the pressure must be made directly upon the centre of the bone, not upon its lower end. If the quadriceps is relaxed and the patella drawn down, the lower end rests upon a soft cellular pad of fat, and even when there is only the normal amount of fluid in the joint the sensation of floating is easily produced if pressure is made on the apex.

In the *ankle* the chief swelling is behind, on either side, between the malleoli and the tendo-Achillis, and in front lifting up the extensor tendons. In the *elbow* it lies on either side of the tendon of the triceps and over the head of the radius. In the *hip* and *shoulder* there is, on the other hand, only an ill-defined fullness—most marked in the former beneath Poupart's ligament, in Scarpa's triangle, and shown particularly when the limb is abducted, flexed, and everted; in the latter, raising the whole of the deltoid.

*Pain* is always present; sometimes it is very severe and of a tense throbbing character; often it is worse at night, and always if an attempt is made to use the part or press the two bones together. The skin is freely movable over the deep structures; there is no redness or œdema, but it is excessively tender, and at times even the weight of the bed-clothes can scarcely be borne. Usually there are

spots, peculiar to each joint, much worse than the rest. On the inner side of knee, for example, there is one on a level with the upper border of the articr surface of the tibia; in the hip it lies behind the trochanter, and in the kle in front of the external malleolus. The *flexor muscles* are in a state of *tonic ntraction*, so as to limit the amount of movement as much as possible; the *extenrs*, on the other hand, *waste*, and, especially in the case of purulent synovitis id that form which ultimately merges into osteoarthritis, distinct flabbiness and ss of tone may be present by the end of a week. When the joint is superficial e *temperature of the skin is distinctly raised;* and, if it is large, or if several are volved together, slight chills are not uncommon with a certain degree of fever. n some of the constitutional forms of synovitis it may be very severe.

**Course and Termination.**—The subsequent course depends partly upon he exciting cause, partly upon the condition of the patient.

In simple traumatic synovitis, the extravasated blood, if there is any quantity, oagulates in the interior; the hyperæmia and exudation continue to increase for i few hours, or perhaps two or three days, according to the severity of the injury nd the success of the treatment, and then, if the part is kept at rest, resolution ets in. The coagula break down and liquefy; the blood-vessels contract again; he endothelial lining is restored; and the synovial fluid, though it remains colored for some little time, gradually resumes its normal consistence. Occasionally, when there is a high degree of tension, or when the injury is repeated time after ime, the inflammation becomes chronic, and either the synovial cavity remains listended or the walls become thick and rigid and covered over with fringes. Very rarely (unless there is an open wound) suppuration follows.

The same may be said of that form of acute synovitis which results from exposure to cold and wet; only, as the attack is rarely an isolated one, the tendency or the inflammation to become chronic is much greater. When, on the other and, it is due to extension from neighboring structures, or when it is a symptom f some constitutional disorder, whether it is tubercle, gonorrhœa, or one of the cute exanthemata, the termination is naturally dependent upon the exciting use; it may subside without any further evidence of arthritis; or it may extend om one part to another until the whole joint is inflamed.

**Treatment.**—If there is an external wound, this must be dealt with first, cording to its condition. Either it should be closed at once, sutures being used required to draw the deeper parts together; or enlarged, explored, washed out d drained. The chief treatment must be local; the bowels should be well ened, and the diet light and unstimulating, especially if there is any tendency gout or rheumatism; but, unless there is a high degree of fever or a well-marked athesis, internal remedies are of little avail.

*Rest* is of the first importance. Every movement causes pain and makes the flammation worse by increasing the amount of blood flowing through. Unless e attack is very slight, and affects one of the smaller joints only, the limb should placed upon a splint, or fixed by means of a sling or a triangular bandage and sed. The position varies with each joint, and is not by any means that which e patient assumes of himself. The elbow should be flexed to a little less than a ht angle; the hip should be straight, the knee bent ever so little, and the foot, the case of the ankle, exactly perpendicular to the leg.

*Heat, cold, and pressure* are the most effectual means for checking the exudan and preventing tension. Of these the first is limited in its application, and chiefly of service in traumatic synovitis, when the joint, like the ankle, is superal, and the limb can be plunged for a moment immediately after the accident o water as hot as can be borne. Cold is of more general use, and can be kept for a longer time; but after the first few hours its utility diminishes very rapidly. e immediate effect is a contraction of the arterioles; but if it is continued, the ls of the vessels lose their tone and passive congestion follows. A rubber bag, ed with ice, or Leiter's tubing with ice-cold water, is easily arranged in the e of most joints; or, if it is the lower limb, and the patient is confined to bed,

lead and spirit may be allowed to drip from a vessel over the joint. Pressure, if it is properly applied, is by far the best. It must be perfectly uniform, falling on the soft parts as well as on the bones, gentle, and elastic, so that it does not slacken off as the blood-vessels become empty and the part diminishes in size. Absorbent cotton-wool answers all requirements. All the hollows of the limb should be packed with pads until the bones appear buried; then several thicknesses should be placed round the whole, and over all a moderately tight bandage. In the course of a few hours the extreme tension disappears and the bandage can be replaced by a firmer one. Nothing is equal to this for checking hyperæmia and exudation, causing the absorption of extravasated blood, and preventing the distention of the capsule, which is not only the chief cause of the pain (after the immediate effects of the accident have subsided), but, from the weakness it leaves behind it, a source of very grave inconvenience afterward.

Pain, if it is very severe, may be relieved by placing a few leeches over the joint, or by giving a hypodermic injection of morphia. Aspiration is seldom required in cases of simple acute synovitis, though it may be advisable when there is a large extravasation into the synovial cavity, as in fracture of the patella, and it is of importance to empty the joint at once, or when, from the persistence of the swelling and the continued heat, there is reason to fear that the exudation is becoming purulent. Great care of course is necessary; the cannula should be cleaned by boiling in liquid potassæ, so as to make sure that no greasy substance is retained inside; [it should also be made aseptic by passing through a flame, or plunging in absolute alcohol just previous to its use,] and the opening should be valvular and well secured. Very often marked relief is obtained, even if only a few drachms are withdrawn; the tension is lowered; the pain and hyperæmia diminish, and absorption commences at once.

Passive motion should not be delayed too long. As a general rule, it should be commenced as soon as the temperature of the part is normal. Moving the joint once each day, through its whole range, quietly and steadily, cannot excite inflammation or cause severe pain, while it effectually prevents the formation of adhesions and contractions in the synovial wall.

### 2. Chronic Synovitis.

Chronic synovitis occurs either by itself or as part of a general arthritis; but even when it is local at the first, the inflammation always involves the other tissues sooner or later. Sometimes it begins as such, quietly and insidiously; in most instances, however, it follows an acute attack, which, from want of rest or other causes, gradually becomes chronic.

The *pathological appearances* are very variable. The fluid is usually increased in quantity; sometimes there is an immense excess. Generally it is thinner and more watery than normal; sometimes it is almost serous, and straw-yellow in color, and occasionally it is turbid; but it usually retains its lubricating feeling. The surface of the lining membrane is dull and opaque. In places it is rough and velvety; and around the margins where it is thrown into folds it may be covered with fringes and villous processes as thickly as in chronic osteo-arthritis. The fibrous capsule is softened and weakened at some parts; thickened and rigid from the organization of the exudation at others. In some cases the weaker portions are stretched to such an extent that the shape of the sac is completely altered; hernial pouches form between the fasciculi, owing to the continued pressure, or the walls are gradually absorbed until a communication is established with neighboring bursæ. In others the flexibility is lost; the soft cellular pads, which should yield at once to the pressure of the bones, are hard and dense; the delicate vessel-bearing tissue is thickened and contracted; and the folds of the synovial membrane, especially where they are pressed together and kept at rest for any length of time, as on the inner side of the shoulder joint, become adherent to each other, so that they cannot open out as the bones separate. In rarer

the exudation in the interior becomes organized, and long slender adhesions eft, passing from one surface to another. They form during the acute stage ie inflammation, while the endothelium is detached and the walls are covered lymph; and while still soft they are gradually stretched by some change in position of the joint.

**Symptoms.**—The signs of inflammation are much less marked than in the e form; the temperature of the part, for example, is scarcely raised, the pain ot so severe, and there is no constitutional disturbance; but there is evidence nuch greater changes in the tissues; the muscles, especially the extensors, are phied; the outline of the joint is altered; sometimes the bones stand out too ninently, from the wasting of all the tissues over them, more often they are ealed by the distention of the synovial cavity. The shape of the synovial sac ot the same; the weaker parts of the capsule yield more than the rest; the ch under the quadriceps, for instance, in the case of the knee is enormously eased in size, while the tough fibrous capsule on either side of the patella is cely affected. The joint is stiff and weak, with a feeling of insecurity and plessness; the range of movement is limited, full extension in particular being ossible. There is crackling or grating, as one surface moves upon the other; metimes it is the soft silken crepitus of cartilage that has lost its polish, more quently the rough sensation produced by the synovial fringes as they are eezed between the capsule and the bone; and there is always tenderness on ssure, not only at the usual points, but at others where the capsule is thickened m the organization of lymph, or where it has grown out into little pedunculated mes which are caught between the finger and the bone.

**Prognosis.**—In most instances, tubercular disease for example, the syno-tis is merely part of a general arthritis, or is associated with some diathesis, d requires special description. Sometimes, however, it is local and exists by elf.

In the early stages, while the exudation is still cellular and to a great extent uid, resolution is usually complete if the cause is removed. Later, when organi-tion has set in and the wall has undergone a definite alteration in structure, the ospect is not so favorable. When part of the capsule is hard and rigid, or corporated with the tissues around, or when the folds are hypertrophied and vered over with fringes, recovery is rarely perfect; the joint never moves easily, remains weak and insecure; one spot in particular is painful, or one special tion; the amount of fluid is too great, though it varies from time to time, and ere is always the chance that a sudden strain, or the slipping of one of the dunculated outgrowths between the bones, may give rise to an acute attack.

**Treatment.**—The sooner the exudation is absorbed the less the risk. If it left for any time the capsule becomes stretched, and for want of proper tension e fluid collects again as soon as it is removed. Gentle uniform pressure—an astic bandage, for example, over properly arranged pads—is most successful, pecially in the early period, while there is still a certain degree of hyperæmia. s this disappears, friction and massage may be used for a few minutes each y to prevent the wasting of the tissues and increase the flow of lymph in e vessels. Then, as the fluid disappears and only thickened bands and fringes e left, douching with a jet of warm water under moderate pressure, steaming, mpooing, and other more vigorous remedies may be tried. Very great relief often obtained by the use of counter-irritants: oleate of mercury of various grees of strength, with morphia, painted on the skin; iodine applied every day il there is very distinct tenderness; or, especially where there is an unusually sitive spot, light flying blisters repeated at frequent intervals. Scott's dressing invaluable when the fluid persistently re-collects. The joint is covered over h strips of lint, on which is spread camphorated mercurial ointment (an ounce strong mercurial ointment to a drachm of camphor); over this are placed two three layers of firm adhesive plaster; and then the whole is fixed and rendered ure by means of a starch bandage. This should be removed at the end of a

week at the latest; by that time the strapping is too loose to exert any pr and very often a sufficient effect has been produced upon the skin. Not quently it is advisable to vary the treatment, protecting the joint in the while from cold and overwork, without, unless the temperature is distin raised, laying it up completely.

In some cases, in which the effusion persistently returns again and again out any other sign of inflammation, aspiration and injection with a stimula fluid may be tried. A one per cent. watery solution of carbolic acid or tinctu iodine and water (one part in ten) is usually employed. The fluid is injected i the joint, brought into contact as far as possible with all parts of the syno cavity, and then allowed to escape again, the aperture being closed at once. limb should be thoroughly packed with cotton-wool and kept upon a splint u the reaction that follows has subsided. Afterward a certain amount of sup (an elastic bandage for example) must be worn to prevent any further accu lation. This treatment, however, is by no means devoid of risk: the react may be very much greater than is wished, and it must not be forgotten that passive collection of fluid (*hydrops articuli or hydrarthrosis*) is in many c rather a sign of incipient osteoarthritis, or of that form of arthropathy associa with locomotor ataxy, than of simple chronic synovitis. [The injection of io form emulsion is very valuable, and is seldom attended by any trouble complication.]

In others again the joint continues stiff and painful without any increa the amount of fluid, and without any rise of temperature, every attempt at u it bringing back an acute attack, although the skin in the intervals is cold, b and congested. This may be due to the presence of bands or adhesions in interior of the joint or in the loose tissue around the capsule; but much m frequently it arises from simple disuse and defective circulation. The appear of the part is characteristic; it has a helpless, withered look about it, the s does not fall into its natural folds, or move easily and freely over the promine beneath; it seems as if it were shrunken on, and it is always cold, though patient may complain of a constant burning pain. Movement is gene exceedingly limited and very painful, especially at one particular spot, an many cases the least attempt at carrying it beyond a certain point is followed a return of the acute symptoms. Such cases as these may generally be cure once by massage, douching, and friction; the circulation improves, the becomes warm again, and the synovial folds, which are, as it were, glued toge from having been kept at rest too long while softened by inflammation, gradu open out and allow the proper movements to take place freely. Sometimes, h ever, this fails; instead of recovering, the joint continues tender, particularl one spot; or, while other movements can be performed with ease, one rem impossible, from the pain it causes. In this case it is probable that the synovit kept up by the stretching of an adhesion, and it may be brought to an en once by suddenly rupturing it. The action and the spot must be noted carefu the muscles thoroughly relaxed, preferably by an anæsthetic, the proximal segm fixed, and then the band torn across once for all by suitable manipulation. condition, however, is much more rare than the former.

## ARTHRITIS.

### Simple Inflammation.

This may either begin in the synovial cavity and spread to the rest of joint (primary), or follow disease of the articular ends of the bones or c adjacent structures (consecutive). It may be acute or chronic, and accordin the nature and persistence of the cause it may subside or end in disorganiza Suppuration is a complication and does not occur unless the vitality of

...s is impaired and the pyogenic organisms gain entrance in sufficient ...bers.

**Causes.**—Traumatic inflammation of the synovial lining is of common ...rrence; but, except in the case of a neglected loose cartilage or frequently ...eated sprains, it seldom happens that mere mechanical injury is sufficiently ...ense or prolonged to affect the other tissues of the joint. Chemical irritants ...er give rise to a specific form (gouty arthritis, for instance), or, as in the case ...septic decomposition, are so severe that suppuration follows almost as a matter ...course. A typical example of simple inflammation is sometimes met with ...en there is a neighboring focus of inflammation (consecutive arthritis); the ...ee-joint, for instance, may be more slowly disorganized, as a result of chronic ...itis of the lower end of the femur, without pus ever making its appearance ...the articulation.

**Pathological Appearances.**—The earliest changes take place in the most ...scular parts. The synovial membrane is swollen, softened, and reddened with ...travasations; the cavity filled with a turbid blood-stained fluid, and the articular ...ds of the bones and the soft structures around deeply congested. The cartilages, ...they contain no vessels, undergo no active change, and the same is true, although ...a less extent, of the ligaments and capsule.

If the irritant continues, this becomes more marked. The amount of exudation increases, the fluid in the interior becomes thick, the ligaments soften, their fibres separate from each other, and all the interstices are filled with lymph.

The synovial membrane and the capsule are so swollen and thickened that they can scarcely be recognized. The cartilages lose their lustre and become opaque; they melt away on the surface and grow thinner and thinner, while around at the edges they are eaten out in little pits by the granulations that spring from the vascular circle around the bone; the periosteum is thicker than natural; it can be stripped off with ease from the surface beneath, and the bones themselves are deeply congested and so soft that they can be cut with a knife.

These extreme changes are only seen when the irritant is an intense one and suppuration impending. When the cause is a loose cartilage or a neighboring focus of inflammation, they are much less marked; and as in these cases there is rather a succession of slight attacks at frequent intervals, than a single very severe one, at one time all the tissues may be swollen, softened, and filled with exudation, at another they may be dense and hard from organization and repair; but, inevitably, if the irritant is continued sufficiently long, all the tissues of the joint lose their natural texture and it becomes more or less crippled and ankylosed.

**Repair.**—The destruction may be arrested at any point; the irritant ceases to act, the hyperæmia subsides, and the exudation partly becomes absorbed, partly organized.

In most traumatic cases this takes place before the synovial membrane is destroyed or any very serious changes are produced in the ligaments or cartilages; and then, although the capsule is left thickened and somewhat rigid, a very fair range of movement is regained. Even when the surface of the cartilage has been eaten away and the ligaments softened this is still possible, especially in children, so long as there is no displacement. The fibrous tissue that fills up the deficiency presents a sufficiently smooth and even surface, and the ligaments soon become firm again. If, however, the irritant persists (as in chronic osteomyelitis of the lower end of the femur when the sequestrum is locked in), the joint may become so rigid and painful that the patient is driven at last to seek relief in operation.

**Symptoms and Course.**—Acute arthritis presents the same class of symptoms as acute synovitis, but they are very different in degree. The pain is more severe. The limb is flexed and held perfectly rigid. The skin feels burning hot, and, though it may be white at first and in the more chronic cases, reddened patches may show themselves over the part where the capsule is thin and superficial. The whole of the joint is swollen, not the synovial sac only; the shape is different; it is more rounded and uniform, spreading upward and downward over the bones,

and not following the outline of the cavity. The consistence of the swelli firmer; the tenderness on pressure is greater, and, though one or two spots ma worse than the rest, it is not confined to any part in particular. The ext muscles waste even more quickly; the flexor ones maintain a state of rigid traction, broken only by sharp spasms, especially at night, and the constituti disturbance is much more severe.

These symptoms are followed by the others which do not occur in synov As the ligaments become soft and yield, undue mobility is allowed. *Displace* of the articular ends and even *dislocation* may follow, the weight of the lower ment of the limb and the persistent spasm of the flexor muscles drawing the bo away from each other. *Friction* is felt when the joint is moved, owing to the c tilages having lost their smoothness of surface. At the same time, or even bef this, peculiar *starting-pains* make their appearance. These rarely happen in t daytime or at night, when the patient is sound asleep; but as he is losing con sciousness and the muscles are relaxing their vigilance there is a sudden violen jerk of the limb and the two bones are driven together with the most excruciating pain. This may happen time after time and night after night, until the patien dreads going to sleep, and keeps himself awake as long as he possibly can. I always means that the bones are inflamed, and often that the cartilages are eroded The start is due to the sudden reflex contraction of the muscles. As they relax in sleep, one part of the joint moves ever so little upon the other, the stimulus is car ried up to the nerve-centres, there is a sudden spasm in response, and the two bone are brought forcibly into contact. It is not uncommon for them to be presen when no grating can be detected, either because the surface of the bones is covere with granulations, or because the cartilage is not yet removed.

If the irritant is very intense (such as the poison of septic decomposition) an the inflammation continues to spread, the periarticular tissues become involved the skin becomes red and œdematous, especially along the inner side of the limb the swelling increases rapidly in size and becomes more diffuse; the pain grow more severe and continuous; the constitutional disturbance becomes worse an worse, and at length the pyogenic organisms gain the upper hand and suppuratio sets in, sometimes in the joint itself, sometimes in the tissue around.

**Diagnosis.**—Occasionally there is some difficulty in determining wheth the inflammation involves the joint or some of the structures around it. Th usually occurs in connection with bursæ (under the deltoid in the case of th shoulders, between the iliopsoas and the front part of the capsule in the hip; an in children under the crureus, between the quadriceps and the femur); but a carefu examination nearly always settles the point at once. The shape of this swelling different; movement in some directions is much more free than when the joint involved, pain is less severe, and the constitutional symptoms are much le marked.

**Treatment.**—1. *Primary Arthritis.*—(*a*) *Acute.* In this, as in synoviti local treatment is the most important. If the fever is high and the constitution symptoms severe, small doses of aconite (one minim of the tincture), or of ant mony, may be given at frequent intervals; the bowels must be kept open, the di strictly limited, and antipyrin or quinine may be tried; but unless there is evidenc of some definite diathesis, such as gout or rheumatism, constitutional remedies themselves are of little avail.

*Rest* is the first consideration. Every movement of the joint not only caus intolerable pain, but makes the inflammation worse. At the very earliest sig whether it is due to a wound or not, the limb should be placed upon a suitab splint. This varies, of course, with the nature and situation of the joint; it mu fix both segments, the one above and the one below; it must hold the limb in most convenient position, supposing it should become stiff; it must enable co tinuous extension to be made if it is required, and it must be arranged so that cold, compression, or counter-irritation may be applied without its being necess to move it. For the hip, either Bryant's or Thomas's splint may be used, acco

to the position of the joint, which is certain to be flexed, and which may not be straight for days; in the case of the knee, either Thomas's or McIntyre's. The anterior ones do not give sufficient immobility, or prevent the eversion which always takes place if the ligaments are softened and the limb is left to itself; but, both for this, the foot, and the joints of the upper extremity, nothing answers better than one of the various forms of plaster splints (especially Gamgee's absorbent cotton-wool dipped in plaster cream) or poroplastic felt.

*Extension* is part of rest, and, especially in the case of the hip and knee, is almost indispensable. It prevents muscular spasm and stops the starting-pains at once and in a fashion which nothing else can; it prevents the two bones being jammed against each other, and saves the articular cartilage from absorption; it helps to steady the limb and bring it into the right line, and it checks the tendency to displacement. It is managed most easily by means of a weight attached to a stirrup, the amount being proportioned to the size of the limb.

*Elevation*, *cold*, and *compression* are invaluable for checking the hyperæmia and reducing the tension of the part. With regard to the first, Lister has shown that not only does the venous blood return more freely when a limb is raised, but that there is as well a contraction of the artery under the influence of the vasomotor nerves. Of cold it is unnecessary to say anything, the only point is that it must be continuous and not intermittent. Ice-bags may be placed over the joint, or Leiter's coils wound around it; or, what is perhaps more effectual when the affected joint is covered thickly up, an ice-bag may be laid along the main artery supplying the limb. It has been proved that this has a very decided influence upon the temperature of the parts below. Compression is even more important, but it must be carried out thoroughly and carefully, or it may make the congestion worse. The whole limb, from its extremity to well above the affected joint, must be evenly packed with layer upon layer of absorbent cotton-wool. On the outside of this longitudinal strips of torn mill-board soaked in plaster cream are placed to give firmness and resistance; and then over all a bandage carried evenly upward, diminishing the pressure ever so little toward the end.

Other remedies are occasionally of service. If the inflammation is very acute, ten or a dozen leeches may be placed over the joint. The skin may be covered over with a mixture of equal parts of extract of belladonna and glycerine. Morphia may be given hypodermically to relieve the pain and restlessness and procure sleep; and if the joint is very much distended, aspiration may be used to draw off some of the fluid.

(*b*) *Chronic.*—If this treatment is successful, the severity of the symptoms diminishes, the fever subsides, the hyperæmia disappears, and the exudation is in great measure absorbed. Very often, however, more or less organization takes place, repair is incomplete, and a certain amount of chronic inflammation persists. The muscles are wasted; the joint is swollen and stiff; movement is painful; the temperature of the part continues higher than normal; there is tenderness on pressure; and every attempt at using the limb threatens to bring back an acute attack.

When this occurs rest is still essential; it must be rigidly enforced so long as the temperature is raised, although it may not be necessary to confine the patient absolutely to bed. With the aid of Thomas's splints and a patten under the opposite foot in the case of the hip and knee, and gum and chalk, leather, or poroplastic, for other joints, patients may be allowed to get about to a certain extent upon crutches as soon as the acute period is passed, very often with great benefit to their general health. Compression is not of so much service unless there is a large amount of exudation still; but a great deal of good may follow the judicious use of counter-irritants. Blisters, iodine, and the oleate of mercury are of service in the slighter cases only; Scott's dressing is of greater use, as it may be applied as a splint as well; but when there is evidence, from the shape of the swelling and the severity of the pain at night, that the bone is in a state of chronic inflammation, and even in some cases of starting pains, nothing succeeds like the actual

recovers its power within a short time of the a

Later, when the inflammation has subsidec left, proper means must be taken to restore t mobility of the joint.

2. *Consecutive Arthritis.*—The diagnosis primary arthritis is of especial importance. abscess in the bone, and this can be opened so the joint is too seriously involved, complete rec when there is a sequestrum, and it involves th possible to remove it and leave a comparatively be done, as in many cases of chronic osetitis of the joint gradually becomes stiff and almost us inflammation, or, worse still, the abscess finds up acute suppurative arthritis.

The shape of the swelling is entirely differ mation of the joint, at least in chronic cases quickly. In the knee, for instance, instead of of the synovial sac, it is very much larger on o and 271), and it begins upon the bone, caus into the periosteum and the soft tissues lying ov particularly over the swelling ; sometimes it is skin over which is slightly puffy and œdematou a different character ; there is a constant, deep worse at night and after any exertion, and sev of the inflammation. In traumatic cases this is ones, on the other hand, owing to the peculia which the affection advances, it is much less early ; in synovial arthritis they do not begin the soft, cancellous tissue at the end of the bone they commence as soon as the inflammation ap the same reason intra-articular pressure, as whe the other, is a great deal more painful. Finally inent feature.

The first object is to check the progress For this appropriate constitutional and local m

In many instances, however, in spite of transient improvement, the pain persists, the swelling refuses to disappear, the effusion in the joint continues, and the local tenderness becomes more and more distinct. When this occurs there must be no further delay, an attempt must be made to reach the seat of the disease by incision in the bone, without, if it can possibly be avoided, implicating the joint. Even if no pus is found, the operation gives relief by diminishing the hyperæmia, with, so long as the synovial cavity is not opened, the least amount of risk. Sometimes the periosteum is thickened or detached from the surface of the compact tissue beneath; occasionally a small sinus can be found, or the bone is altered in texture. In other cases everything appears to be normal; but even then, so great is the risk of leaving a caseous or suppurating focus in the centre of one of the articular ends, that if, before the operation, one spot was definitely tender or œdematous, a circle of bone should be removed with the trephine and the interior explored with a small gouge, or, what answers better, a steel director set in a rounded wooden handle. With this the difference in the resistance offered by healthy bone and by that which is inflamed and softened can be appreciated at once, even when there is no actual cavity.

FIG. 237.—Osteitis of Upper End of Diaphysis of Tibia, ending in suppuration. Probably it was tubercular in origin; on the outside is a layer of sub-periosteal new bone, but notwithstanding this it made its way as well outside as into the joint.

If an abscess is found it should be opened freely, any loose fragments of bone that lie in it removed, and the cavity thoroughly scraped so as to destroy all the soft granulation tissue, washed out with a solution of perchloride of mercury (one part in 1000), and plugged with iodoform gauze. This may be removed at the end of twenty-four or forty-eight hours, and a large drainage-tube inserted.

If the disease has not yet broken through the articular cartilage an excellent result may be obtained by this; the whole of the os calcis, for example, may be erased, leaving merely a periosteal shell, without the neighboring synovial membranes being lost. If, unhappily, the disease has spread too far, and suppurative arthritis or pulpy degeneration of the synovial membrane has occurred already, further measures, drainage, arthrectomy, or excision will be necessary, according to the condition of the parts.

### SUPPURATIVE ARTHRITIS.

This, like the former, may either begin in the joint or spread to it from the adjacent structures. It never arises without the presence of pyogenic organisms, acting on tissues the vitality of which is already impaired by other irritants. If these are of but slight intensity and the general nutrition is good, the destruction is limited; if, on the other hand, they are severe (as in septic decomposition), or if the tissues are badly nourished (whether from prolonged intemperance, excesses, kidney disease, or other causes), the destruction is widespread and complete.

**Causes.**—The primary form very seldom originates without a wound; exceptionally in those whose health is impaired by intemperance and renal disease, a simple synovitis steadily progresses from bad to worse, until at length the tissues yield and give way and suppuration sets in.

The consecutive one is nearly always the result of suppurative osteitis. In acute necrosis the inflammation may spread along the periosteum until it gains the capsule, or work its way between the epiphysis and the shaft, and then turn upward through the soft tissue of the former until it reaches and undermines the articular lamella. Acute epiphysitis of infants is sometimes known as suppurative arthritis, from the certainty with which the articulation is destroyed. In chronic osteitis,

all as from the tissues around, when the discharge of pus ceases and organiza- begins, the opposing surfaces grow together, the cavity is obliterated, and dense bands of cicatricial tissue form between the ends, or osseous union, bony ankylosis, takes place.

**Symptoms.**—These are the same, both constitutional and local, as those of arthritis, but infinitely more severe. When the joint is a large one and the acute, death may follow from septic absorption within the first few days. is a rigor or a succession of chills; the temperature rises rapidly to 105° or 106° F.; the pulse at first is full and bounding, but in a very short time it mes weak and feeble; the tongue is dry and brown; sordes appears upon the and teeth; delirium sets in; and the patient sinks from acute blood-poisoning out the symptoms abating in the least.

In other cases the constitutional symptoms are less severe; the temperature is dingly high, with occasional rigors; at first it is continuous; after a time it of a morning, until, when suppuration has become free, it assumes the hectic

The pulse is soft and compressible without losing its frequency; the appe- completely lost; the tongue continues dry and brown; the emaciation is me, the cheeks become hollow, the eyes dark and sunken, and if the patient es pyæmia and other acute infectious disorders, amputation is frequently ired, either because the joint is hopelessly disorganized and the limb useless, prevent the patient sinking from exhaustion.

In others again, when the suppuration is not assisted by decomposition, or a the joint is a small one—in one of the fingers, for example—the effect is much less, but in acute suppurative arthritis it is always severe.

The local signs are equally grave. If the joint is a large one the whole limb ollen; the outline of the synovial cavity disappears; the skin is burning hot dusky red, either in patches or all over; and the inflammatory œdema spreads he whole of the inner side. The pain is most intense, the patient screaming if the bed is touched, and the limb is flexed and held perfectly rigid, often ped with both hands so as to prevent the slightest movement. Displacement, t has not occurred already, very soon follows. The ends of the bones grate n each other, owing to the cartilages having sloughed. The starting-pains at t become simply agonizing; and then, if the patient survives, the skin becomes ned at some spot, fluctuation makes its appearance, and the pus discharges lf externally.

In acute suppurative arthritis of the knee, it occasionally happens, when this ge is reached, that there is a sudden and most deceptive appearance of improve- nt; the capsule of the joint gives way at its weakest part, under the tendon of quadriceps; the pus escapes and spreads along the femur, until it is turned de by an aponeurosis; the joint diminishes in size; the tension becomes less; l the constitutional symptoms are decidedly improved. Unhappily this does t last long; the swelling soon shows itself high upon the outer side of the thigh, l if the abscess is not opened and drained at once, the symptoms become even re than they were before.

**Diagnosis.**—In the acute form, especially that which follows a wound of joint, there is seldom any difficulty; sometimes, however, when suppurative ritis sets in as a result of constitutional infection, and it is a question between and purulent synovitis, the signs are at first far from obvious. The occurrence rigor; a rapid rise of temperature; the shape of the swelling, which is no ger that of the synovial sac; the presence of œdema and of a peculiar dusky ness of the skin, and the intense character of the pain, are most significant. ny case of doubt there should be no hesitation in using the aspirator and drawing some of the fluid from the interior, with the precautions already cribed. If the contents are still thin and serous, the product of catarrhal sup- ation, removing a certain quantity relieves the tension and the hyperæmia, hen absorption may commence of itself. If, on the other hand, they are

thick and curdy, the sooner the contents are evacuated and the tension lowered the better the prospect of preserving the cartilages and saving the joint.

**Treatment.**—Suppurative arthritis must be dealt with at once. The synovial cavity must be thoroughly drained; the poison that clings to its walls destroyed or washed away; and all further source of irritation, whether it is septic decomposition, tension, movement, or pain, absolutely prevented.

If there is any doubt as to the presence of pus; or if, as in some cases of constitutional infection, there is a suspicion that it is really a purulent catarrh, kept up to a great extent by tension, without the cartilages or the surrounding tissues being seriously concerned, aspiration may be tried. On the other hand, if the skin is red and œdematous, if the shape of the swelling is no longer that of the synovial sac, or if the arthritis is due to a wound, or an abscess that has formed in connection with the bone or one of the surrounding structures and has burst into the joint, the only hope lies in free incision and thorough drainage. The earlier this is accomplished the better. If the patient is not already poisoned by septic absorption, and the synovial membrane is not yet destroyed, a fair amount of movement may be regained; if it is not done in time, either the patient will sink from acute septicæmia or exhaustion, or if he recovers the joint will be hopelessly disorganized.

The limb must be fixed upon a splint, protected with waterproof pads, so that there can be no displacement or spasm, and every part of the joint laid open; the difficulty of accomplishing this, in the larger and more complicated ones, is chiefly responsible for the ill results that follow.

In the case of the knee a free incision must be made down each side of the patella, slanting rather backward; and a pair of dressing-forceps pushed through the back of the joint into the popliteal space on the outer side of the middle line, until the point is felt beneath the skin. Then a small cut must be made, the forceps driven through, and a drainage-tube drawn back. Even with these three openings, however, drainage is not sufficiently thorough, and the joint must be kept free from any accumulation by some other means. In the early stages continuous irrigation answers admirably, pure water being allowed to flow into the joint at one side, and out again at the other, carrying away with it all the secretion; decomposition cannot occur, as none of the pus is left. But when the smooth synovial surface is destroyed, and abscesses are forming, it is very difficult to make the fluid (which will follow the line of least resistance) circulate sufficiently to wash out all the recesses. More may be done in this case by the introduction of large and firm-walled drainage-tubes at every available spot, syringing out thoroughly with a solution of bichloride of mercury (one part in 2000), and then covering the whole with a thick layer of absorbent moss or wood-wool. The poison is partly washed away—partly, so far as it lies upon the surface, destroyed by the action of the antiseptic; tension is impossible; decomposition cannot occur without fluid; absolute rest is ensured; and the gentle, elastic compression effectually prevents hyperæmia and limits the amount of exudation.

In the case of the ankle, elbow, wrist, and the smaller joints, the same plan may be followed, varied slightly in its details. Thus it is more effectual to immerse the part bodily in a solution of bichloride (one part in 10,000) for two or three hours after the incisions have been made; and iodoform may be freely dusted in as soon as the fluid has drained away; owing to the smaller absorbing surface, there is less risk of poisoning. Even when the joint is loose and grating, a very fair result may frequently be obtained by means of this kind; the suppuration ceases, the granulations begin to organize, fibrous bands form around, or, if the disease is far advanced, between the bones, and repair takes place so far as the previous destruction and the health of the patient will allow it.

Great care is required throughout to keep the limb in position and prevent displacement. Partly owing to the weight of the lower segment, partly to the action of the flexor muscles, one bone is certain to be displaced from the other if

he joint is left to itself without proper splints; and later, when the attack has ubsided and the cicatricial tissue has begun to contract and grow rigid, there may e the mortification of finding that the joint is fixed in such a position that the limb is almost useless, unless excision or some other operation is performed.

Amputation may be required in the later stages of the disease, to prevent the patient sinking from hectic or exhaustion, or because the limb is too much disorganized to be of any use. It should never be performed during the acute inflammatory period, except as a last resource to save the patient from dying of septicæmia, and then, if the joint is a large one, the prognosis is almost hopeless. In the elbow and shoulder, very good results may be obtained by excision, better than by waiting for ankylosis; and the same plan may be followed in the case of the hip, when the upper extremity of the bone or the acetabulum is extensively diseased, with the view of saving the patient from the effects of prolonged suppuration.

### Arthritis from Secondary Infection.

#### (*a*) *Pyæmic Arthritis.*

Inflammation of joints is of common occurrence in pyæmia, although, without any reason being known, it varies very much both in frequency and intensity. In some cases a large number of joints is involved within the first few days, and if the patient lives sufficiently long, the destruction is rapid and complete; in others only one is attacked, or one or two at long intervals, and the effusion remains in the condition of a simple purulent synovitis for a considerable time before it involves the tissues around.

It always begins as synovitis, and the effusion is purulent from the first; generally it is of a peculiarly oily character, and greenish or yellow in color, from the blood with which it is mixed. If the attack is an acute one, this is succeeded by suppurative arthritis: the synovial membrane becomes swollen and vascular, the surrounding tissues sodden and œdematous, and within forty-eight hours the cartilages undergo necrosis and the joint is hopelessly disorganized. If, on the other hand, it is chronic, the interior of the joint may retain its smooth and even character for days, without any evidence, even of hyperæmia; and at the end of that time the effusion may spontaneously disappear, leaving the joint capable of a certain range of movement, but generally more or less crippled from fibrous adhesions, or weakened from the extreme distention of the capsule.

**Symptoms.**—Pyæmic synovitis is rapid and very insidious in its onset, often beginning without any complaint of pain. One of the joints, especially the knee, or (it is said) the right sterno-clavicular, suddenly becomes filled with fluid; the synovial cavity is distended; fluctuation is distinct; and the limb assumes of itself the characteristic flexed position. The skin at first is pale, or marked by a scattered erythema; very soon, if the capsule gives way, it becomes oft and doughy, pitting on pressure, and of a peculiarly dusky hue; and then, a rule, the pain becomes very severe. In the acute cases a rigor is not common at the commencement; the muscular wasting is peculiarly rapid; the rtilages may be destroyed within forty-eight hours; starting-pains are very ere; and, owing to the great amount of fluid and the rapidity of the destruc-n, displacement of the ends of the bone is very likely to occur, unless special cautions are taken to prevent it. In the more chronic ones there is less heat l less tension; the skin is unaffected; often there is no increase in the constiional symptoms; and not unfrequently the effusion disappears from the joints ost as rapidly as it came, and perhaps makes its appearance in another. thological dislocation, particularly of the hip joint, is not uncommon under se conditions, forming the so-called *dislocation by distention;* the head of the e lies still within the capsule, which it has stretched over itself. It differs m *dislocation by destruction* in that the cartilages on the articular surfaces and bones beneath them are intact.

**Treatment.**—Careful examination should be made every day in a case of

before the surface is destroyed, and drain it. I
is not allowed to collect anywhere in the int
limited amount of movement is possible; much
the cartilages undergo necrosis, granulations s
and osseous ankylosis ensues; or the patient sin
complication, or from exhaustion. Amputatio
required at a later period, either because the lin
from hectic or amyloid disease.

(*b*) *Puerperal Art*

This is a form of pyæmia consequent on s
of the uterus after parturition, due in most case
tion of some portion of the placenta. So far a
it does not differ materially from other form
leading to rapid disorganization and destructior
or chronic, affecting often the knee joint only;
thoroughly disinfected, and no further absorpt
prognosis is fairly good.

(*c*) *Exanthematic A*

Inflammation of the joints is of common
exanthemata, sometimes appearing during the co
afterward, as one of the sequelæ. In many ca
septic absorption from ulcers upon the skin or
not differ in any material respect from ordina
never passes beyond the stage of synovitis, a
without leading to any more serious result tha
articulation; and occasionally it is to all
rheumatic fever or the acute form of osteo-arth

In typhoid, the hip seems to suffer more
even dislocation may take place suddenly, wi
muscles are relaxed; the capsule of the joint
insinuates itself between the articular surfaces,
and abduction is sufficient to tilt the head o
Owing to the want of power of the muscles.

gonorrhœa (though the proportion of cases in which it occurs is exceedingly small), whence its common name, gonorrhœal rheumatism; but it may follow any urethral discharge, or even the passage of a catheter, and, though much more rarely, a similar affection may occur in women in connection with menstruation, following parturition or dependent upon leucorrhœa. According to Clement Lucas it is present sometimes in cases of ophthalmia neonatorum.

The nature of this affection is even more doubtful than that of the exanthematic variety. In some cases it appears to be pyæmic, due to septic absorption from ulceration of the urethra, and ending in acute suppuration and destruction of the joint; but in the majority there is very little tendency to the formation of pus. That it is directly connected with the condition of the urethral mucous membrane is shown by the fact which has many times been noted, that the inflammation is liable to return, not only with every succeeding attack of gonorrhœa, but even when, without this, the urethral mucous membrane is subjected to any unusual degree of irritation (possibly in these cases the gonorrhœa is latent). It seems probable that it is due to the absorption of some poison from the urethra, and the gonococcus has been found on several occasions in the fluid of the joint; but it is also possible that it may be the result of reflex irritation of the nervous system. Ord, for example, has shown that a form of arthritis not altogether unlike this occasionally attacks women who suffer from menstrual troubles, the inflammation returning at each period until the climacteric is passed; and although this, too, may be explained as the result of absorption, it is peculiarly significant that in several of the cases in which there was ovarian tenderness with neuralgia on one side of the body, the disease was limited to the joints on that side.

The clinical symptoms and the pathological changes in some of the more severe cases resemble those of acute osteo-arthritis, especially that variety which occasionally follows exposure to cold or over-exertion shortly after parturition or miscarriage; but the analogy must not be pushed too far. Heart complications are not unknown in connection with it, but they are decidedly rare.

**Symptoms.**—Urethral arthritis exists in two well-defined varieties: acute, attended with fibrinous effusion, and involving all the fibrous tissues around and belonging to the joint, so that, when it subsides, dense fibrous ankylosis is left; and chronic, in which the symptoms are not so severe and the effusion is serous in character, but which also leaves behind it considerable stiffness. As in pyæmia, tendons and tendon sheaths are not unfrequently attacked as well, and occasionally other fibrous tissues not connected with joints, such as the lumbar aponeurosis, the annular ligaments, and even the sclerotic coat of the eye.

The acute form is not unlikely to be mistaken for acute suppurative arthritis, though pus is rarely present, and the constitutional symptoms are much less intense. There is seldom a rigor, although a certain amount of shivering is not uncommon; the temperature is not very high or the pulse rapid, and the appetite even may be fairly good. At the first onset several joints are swollen and painful, but it soon settles down to one or two of the larger ones, the knee and ankle in particular. The skin is tightly stretched, red and shining; often there are red lines running up to the neighboring glands, but it does not pit on pressure; the outline of the part is even and rounded, the shape of the synovial sac is lost, the tendon-sheaths and the fibrous tissues around are filled with inflammatory exudation, the temperature is raised, and the pain, especially when the part is touched or moved, is almost intolerable. The worst points generally correspond to the attachment of the ligaments. At the end of a week or ten days the severity of the symptoms begins to subside, the pain becomes less intense (except when an attempt is made to move the part), the redness disappears, and the skin becomes more or less wrinkled. The effusion is absorbed to some extent, but a very great deal of it becomes organized inside the joint as well as round it, and the ankylosis may be so firm as to give rise to the suspicion of its being osseous. For this reason, and because the ligaments become soft and yielding almost at the first, very great care is necessary to prevent displacement and to keep the joint fixed in the most useful position.

In the chronic form the exudation is less fibrinous and is restricted chiefly to the interior of the joint. The shape of the swelling follows the outline of the synovial sac, there is less exudation around, the pain is not so severe, the patient may even be able to get about to some extent, and, although there is a great tendency to recurrence, each time interfering with the action of the joint more and more, there is rarely the same rigid degree of ankylosis. Softening of the ligaments, however, is very liable to occur, and if the tarsal joints and the plantar ligaments are involved, a very painful form of flat-foot may result.

The diagnosis of the acute form rarely presents any difficulty; in no other variety of inflammation, scarcely even in acute rheumatic fever, is the pain so intense, and from this it can be distinguished at once by the difference in the constitutional symptoms and the extent to which the effusion involves the periarticular tissues. The chronic variety, on the other hand, closely resembles subacute and chronic synovitis, especially when it involves the knee joint only, and it is not improbable, especially as in many cases there is only an insignificant gleet, that the real cause is frequently overlooked.

**Prognosis and Treatment.**—Urethral arthritis is naturally more common in young adult life, but it may occur at any age, and when it is due to gonorrhœa, it may set in at any period of the disease. Perfect recovery is rare; absolutely rigid ankylosis, with complete muscular atrophy, is not uncommon, and the disease may return again and again until the patient is hopelessly crippled.

The condition of the urethra or vagina requires particular attention; every attempt must be made to allay the irritation of the mucous membrane as soon as possible. The use of sedative and astringent injections and bougies does not appear to be attended with any special degree of danger. Constitutional treatment, so far as the joint affection is concerned, is of very little avail. Iodide of potash, salicylate of soda, and the other remedies usually of service in rheumatic fever, seem here to fail completely. The chief reliance must be placed upon local measures, and especially upon those that check the effusion. The limb should be placed upon a splint and raised, the skin covered over with extract of belladonna and glycerine, invested with layer after layer of cotton-wool, and then bandaged as tightly as possible. In acute cases it is necessary to place the patient under an anæsthetic to effect this thoroughly, owing to the severity of the pain; and, as a rule, it is as well to give a hypodermic injection of morphia as soon as consciousness returns; but there is nothing so effectual for getting rid of the exudation, and, as this subsides, the pain and the inflammation and the tendency to displacement disappear with it. It may require renewing on the second or third day, and by that time the outline of the bones becomes distinct again.

After the acute stage has subsided and the joint has become cold, every attempt must be made to restore its mobility. Blisters and counter-irritants may be used to procure resolution of the exudation that has become already organized, or the adhesions may be broken down under an anæsthetic; passive motion and massage must be commenced as soon as the condition of the part will allow it, a certain amount of pressure being maintained in the intervals by means of properly contrived elastic supports; and hot-water douching, galvanism, friction, and every other measure that can improve the circulation and nutrition must be employed to prevent the wasting of the muscles and the stiffening of the joint. Improvement is always gradual, and there is at first a great tendency to relapse, so that a certain amount of caution is necessary; but if the treatment is kept up, a very great deal may be effected, so long, at least, as the adhesions are extra-articular; if they lie inside the synovial cavity they are almost sure to form again, however often they may be broken down.

### Gouty Arthritis.

Gouty arthritis is occasionally met with in young adults, and has even been known in children, but is much more common toward and after middle life. It may be acute or chronic; the former, at least, is much more frequently met with

in men than women. The tendency to it is hereditary, but the number and severity of the attacks are dependent, to a very large extent, upon the mode of life, and particularly upon the diet of the individual. The smaller joints are usually affected first, especially the metatarso-phalangeal articulation of the great toe (possibly because it is so liable to injury from ill-fitting boots), but none are exempt, and it is not uncommon to find, *post-mortem*, abundant deposits of urate of soda in all the larger ones, even though there is no history of their having been inflamed.

In acute cases, provided the joint has not been attacked many times before, the changes are merely those of acute synovitis; all the softer tissues are hyperæmic and filled with exudation; the cavity is distended with a more or less turbid fluid in which there is abundance of urate of soda, and all the loose tissue around is infiltrated too. In chronic cases and after repeated attacks, the changes are more permanent. In the slighter forms there is merely a chalky deposit of urate of soda on the surface and in the substance of the cartilages; but, after the disease has lasted some time, the bones, ligaments, and all the structures around are loaded with masses of the same material to such an extent that nodes formed from it (*tophi*) project beneath the skin. Coincident with this, and possibly to some extent dependent upon it, are degenerative changes similar to those met with in other examples of chronic inflammation. The matrix, as the cartilage, breaks up into fibrils, the corpuscles increase in number, and where there is any pressure or friction it becomes so absorbed and worn that in places it disappears altogether and leaves the surface of the bone exposed. Then this undergoes similar changes; the margins grow out into irregular nodules, the shape of the articular surface is entirely altered, and the distortion and impairment of mobility are as bad as in chronic osteo-arthritis. Later, suppuration may break out in the cellular tissue, leaving sinuses discharging a chalk-like substance from time to time; and ankylosis even has been known to occur in cases in which the inflammation was more than usually persistent.

The symptoms of an acute attack are very characteristic. It nearly always begins in the night, toward early morning; sometimes it is preceded by general malaise for several days; occasionally it follows an accident. The pain is most intense, coming on in paroxysms; it is usually described as resembling the boring of a red-hot iron. There is extreme tenderness, even the pressure of the sheet cannot be borne. The skin is of a peculiar dusky-red color; the whole of the joint is swollen and burning hot, and all the surrounding tissues are thickened and œdematous. At the first onset there may be a feeling of chilliness, even a slight rigor; very often there is a certain degree of fever, but it is seldom severe, and usually subsides of itself in the course of the morning as the pain grows less intense. In really bad cases this is repeated night after night for upward of a week, the days being passed in comparative comfort, except for the feeling of exhaustion and distress, the nights in agonizing pain. As the attack subsides the swelling disappears, the skin over the joint peels off, and if it is the first, or one of the first, no visible effect is left. Not unfrequently a second or even a third joint is attacked as the first is getting well, but the inflammation is seldom so severe.

In the chronic form the pain, heat, swelling, and redness are not so marked, although they vary very much from time to time and the patient is seldom free from them for long. The amount of deformity is much more serious; the loss of mobility is often very great, and there is an especial tendency to the permanent deposit of urate of soda in the form of chalk-stones. The hands are nearly always affected; the metacarpo-phalangeal joints are flexed and adducted, so that the fingers slant down to the ulnar side; distal phalangeal ones may be hyper-extended; the knuckles are enlarged and flattened; movements are much impaired; the skin smooth and glossy, and the temperature is usually raised. Other signs are generally present to assist the diagnosis. Little cysts filled with fluid form on the dorsal surface and sides of the fingers; neuralgia and cramp are of common occurrence; a burning pain in the heel is very often experienced, especially at night;

there is a constant tendency to flatulence and dyspepsia; the urine is loaded with uric acid, giving rise to attacks of urethritis and cystitis; the skin is liable to eczema and psoriasis, the tongue and the pillars of the fauces become smooth and glossy; the teeth become loose, and without the least sign of decay drop out quietly of themselves, and the least indiscretion in diet causes the greatest distress.

**Treatment.**—Rest, position, a moderate degree of warmth, and, if it can be borne, the pressure of cotton-wool lightly applied, are especially useful in moderating hyperæmia of the acute form. The pain may be relieved to some extent by laying over the part lint dipped in a lotion containing a grain of atropin and eight grains of morphia to the ounce, and covering it with oiled silk, or by using a solution of menthol in the same way. Lead lotion is better avoided, and leeching is positively injurious. The bowels should be opened freely and as soon as possible, preferably with gray powder or calomel and colocynth; and if the patient is young and healthy and the attack is severe, colchicum should be given with small doses of iodide of potash, quinine, and sulphate of magnesia. Whether it should be tried in other cases is more doubtful; its value is proportionate to the acuteness of the attack; in many people it causes sickness, purging, and great depression; so that if it has disagreed with the patient on any previous occasion, or if the pulse is weak and feeble, and particularly if the gout is chronic, never really disappearing, and the present attack is merely a sudden exacerbation, it should be given in very moderate doses, and for a short time only, leaving off at once if any signs of depression make their appearance. On the other hand, there is no doubt that it agrees, exceedingly well in many cases, and that by taking it occasionally with quinine, and using other precautions, many patients are able to keep themselves free from severe or prolonged attacks for years without suffering any ill effects.

In the chronic form a great deal may be done by appropriate treatment to relieve the stiffness of the joints and prevent wasting and deformity. Warmth is especially serviceable; sometimes when there is a large deposit of urate of soda, a lotion containing a drachm of bicarbonate of soda or five grains of lithia to the ounce may be applied with benefit. Hot fomentations, local vapor-baths, and massage, gently applied so as to encourage the flow of lymph as much as possible, are certainly of use. In some places, especially over the knuckles, the skin has a tendency to give way and leave persistent ulceration, but every care should be taken to keep it intact as long as possible.

The general treatment, both in the acute and chronic form, is even more important. The diet must be carefully restricted; it must be nutritious and palatable, but all highly seasoned and rich dishes should be avoided, and particularly any excess in meat. Alcohol is better abandoned altogether, certainly malt liquors must be; but a distinction must be drawn in this respect between an acute attack of gout in a young man and an apparently similar complaint in one who is old and feeble, unable to digest without assistance, and liable to attacks of cardiac intermittence from dyspepsia; champagne, sherry, and new wines of all kinds should, however, certainly be interdicted; whether port, particularly old port, in moderation deserves the opprobium that has been heaped upon it is more than doubtful; certainly it is less injurious than many kinds of so-called claret. Alkalies may be taken in moderation, but it must be remembered that many of them, particularly the potash salts, have a distinctly lowering effect. The large amount of fluid that is usually taken with them in the form of mineral waters is beneficial to some extent, as it prevents concentration of the urine and increases the amount of excrementitious matter discharged. Tonics, iron and quinine, are often necessary, especially in the chronic form. Baths are of the greatest value, though much of the reputation many foreign health-resorts enjoy is really earned by the dietetic and other restrictions that are willingly submitted to away from home. The clothing should be warm, a fair amount of regular exercise taken, the condition of the bowels and the state of the digestion carefully attended to, and overwork, mental as well as bodily, avoided as far as may be.

already under different headings, and will only be alluded to here. Rheumatoid arthritis, chronic rheumatic arthritis, arthritis deformans, rheumatic gout, nodosities of the joints, malum coxæ senile, and many other names have been given to some of its varied forms.

**Pathology.**—The pathological appearances are distinctive. The centre of the articular cartilages, where they are subjected to the greatest amount of friction and are furthest away from the arterial circle which supplies them with blood, becomes rough and fibrillated, so that, when placed under water, the surface has the appearance of very coarse velvet (Fig. 239). The upper layers are affected first; the primary capsules are enlarged and filled with secondary ones; the matrix is softened; the capsules form communications with each other; the superficial ones degenerate, break down, and discharge their contents into the joint; and at length only a number of fibrils is left, projecting side by side into the synovial cavity. Gradually the degenerative process involves these too, and the cartilage disappears layer by layer until the bone is exposed (Fig. 240).

This soon becomes affected in the same way; the cancellous tissue of the articular ends grows more open and more vascular; absorption takes place where it is subjected to pressure; the shape is altogether changed; and even when no marginal outgrowths are produced there is a very considerable degree of deformity (Fig. 242). The superficial layer, however, in many cases undergoes a totally different transformation; it becomes harder and denser, until it resembles ivory or porcelain. Whether it is a product of the articular lamella, or is due to calcification in the deeper layers of the cartilage, is uncertain; but in any case it becomes white, dense, and highly polished from the friction it receives. In some cases the whole of the articular area is eburnated in this way and the surface is perfectly uniform and even; in others, especially in hinge-joints, it is cut into grooves from mutual friction (Fig. 241); and in others again worm-eaten patches and bright, highly-polished ones lie side by side.

Around the margin of the joint, where there is no pressure, the effect of the continual irritation is altogether different. Fibrillation of the matrix and proliferation of the cells take place, it is true; but instead of being worn away, the cartilage increases immensely in thickness and forms overhanging lips and nodules which project over the articular edge. Later many of these become ossified, and at length, as the bone is gradually worn away in the centre, and produced in excess around the margin, the shape of the surface becomes entirely altered. The head of the femur, for example, is worn away and flattened from above; the neck is absorbed; while beneath, on the under surface, there is an immense accumulation of new-formed tissue. As a rule when this occurs, the opposing surfaces are similarly affected. Sometimes a fair amount of movement is still allowed to take place

FIG. 241.—Advanced Osteo-Arthritis of Elbow, with Eburnated and Grooved Articular Surfaces and Enormous Lips of Bone (Osteophytes).

tween them; but occasionally they lock into each other and become dovetailed in such a way that practically the joint is fixed. True ankylosis is rarely met with except in the spine. Osteophytes of a similar description are produced on the shaft of the bone, around the attachment of the capsule, and higher up in connection with the periosteum, but their size diminishes rapidly as they recede from the joint (Fig. 241). Occasionally plates and nodules of cartilage and even of bone are produced independently in the thickness of the fibrous tissue.

It is probable that the change is first manifested by the cartilages, but the *synovial lining* of the joint is affected almost as soon. It becomes more vascular and swollen; the fat-cells disappear; the exudation that is poured out from the blood-vessels undergoes organization, and the folds and fringes, which normally are but slightly developed around the margins of the joint, become enormously hypertrophied. The surface is roughened with numerous little outgrowths, and these increase in number and size until they form pedunculated masses, which branch in all directions and cover the whole of the interior. In extreme cases, there is no trace of the original structure to be seen at the base. Very often the ends of these growths become bulbous or club-shaped, and then cartilage-corpuscles and sometimes even bony nuclei make their appearance in them. Occasionally they are detached altogether and drop off as foreign bodies (Fig. 243).

FIG. 242.—Head of Femur, showing the absorption above and the accumulation below, until an appearance is produced closely similar to that of impacted intra-articular fracture with bony union.

In the early stages the *capsule and the ligaments* rarely show any extensive change; they are merely swollen and thickened in proportion to the hyperæmia; but later they may be profoundly affected. Sometimes they are rigid, contracted, and incorporated with the fibrous tissues around, until movement is almost impossible; sometimes, on the other hand, they appear to degenerate, and are softened and loosened to such an extent that the ends of the bones become displaced, and even dislocation may occur. As in the other tissues, the result of the persistent irritation is sometimes thickening and organization, sometimes degeneration and absorption, according to the pressure and friction to which they are subjected.

The *interior of the joint* presents the most varied appearance. In some cases, as already mentioned, it is covered all over with arborescent growths; in others there are only a few large ones here and there, and in others again it is immensely enlarged and perfectly smooth, as if the fibrous tissue of the capsule had become thinned and atrophied. Not unfrequently these different conditions may all be met with together. In one place there are dense, rigid bands, standing by themselves; in another the fibrous tissue is thin and yielding, and is forced among the surrounding structures so as to form a kind of hernial protrusion. Large pouches developed in this way, and communicating by a long and narrow neck with the synovial cavity, are of common occurrence in many forms of osteo-arthritis. Sometimes they are formed from bursæ, which undergo similar changes and gradually enlarge until they come into contact and finally into communica-

tion with the joint; much more often they are genuine *hernial protrusions*, due to t thinner and weaker parts of the capsule being slowly forced out by the intra-artic pressure. They are most common in the knee, projecting through the post ligament, but I have met with them in the ankle, elbow, shoulder, wrist, and h They may be very small; but not unfrequently, especially when they find a c venient interspace, they form gigantic thin-walled cysts, which approach ne and nearer to the skin until they either break of themselves or are opened. I the knee they may stretch half-way down the leg, and point in the calf below t muscular mass of the gastrocnemius; in the shoulder they form a swelling und the coracoid process and down below the middle of the arm, along the course the biceps tendon; in the ankle they may occur either at the front or the back the joint; but, wherever it is, the place of their appearance is no proof of t place of their communication. I have many times dissected them out, and ha

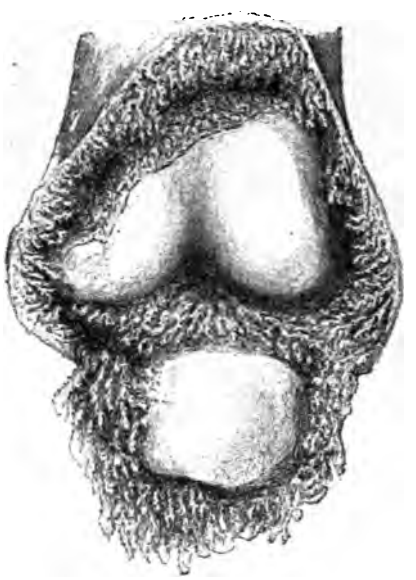


FIG. 243.—Papillary Synovitis, with but little change in the cartilage.

FIG. 244.—Shoulder Joint Laid Open from the Outsid The biceps tendon is absorbed and has formed new attachment for itself in the groove; the he of the bone has left the glenoid fossa and form a new highly-polished articular facet for itself c the under surface of the acromion. The interi of the synovial cavity is thrown into folds. Th affection is nearly always bilateral, which effec ually excludes the idea of injury.

often found a long, devious channel, winding under the tendons, so that whe pressure was made upon the sac the sides were brought together and none of th fluid could be returned into the joint. This fact should be carefully noted, as is by no means uncommon to find large cystic swellings of this sort without an clear evidence of disease of the joint; and in such cases it is exceedingly difficu to prove that no communication exists.

The *synovial fluid* is equally variable; generally it is fairly clear or slight turbid, especially when the attack is acute; occasionally it is a light straw col and gelatinous in character, not like synovia; in some cases the quantity enormous; and in others it may be so scanty that much of the pain and difficu of movement may be reasonably assigned to its deficiency.

*Muscular wasting*, affecting the extensors first, but by no means confined them, is peculiarly rapid in this form of arthritis. The tendons in the neighb

ead of the joint sometimes become ossified; more frequently they are completely orn away, especially when, like the biceps, they traverse the synovial cavity; his one frequently disappears altogether, the muscle forming a new attachment to he groove of the humerus as it passes out under the capsule, and the head of he bone developing a new socket on the under surface of the acromion (Fig. 244). Even the surrounding connective tissue becomes œdematous, infiltrated with lymph in parts, and absorbed in others, so that the outline of the limb is altered altogether and the skin is shiny and smooth.

Suppuration is exceedingly rare. When it does occur it is nearly always due to the formation of hernial protrusions which have grown so large that at length they have either been opened or have broken of themselves, and so have established a communication between the joint and the exterior. Sometimes, however, even then the tissues are able to resist successfully. I have known a chronic sinus in the arm, in connection with osteo-arthritis of the shoulder, discharge for years without destructive inflammation ever setting in.

The true nature of this affection is very obscure. It may be acute, but nearly always it is very chronic. In part it appears to be a result of simple degeneration, for slight degrees of it are met with in healthy old age and in joints that have been kept at rest for a long time; but as a rule there is in addition distinct evidence of some slight but persistent irritant impairing nutrition still further, and leading to the production of the irregular hypertrophied masses round the margins. Occasionally it occurs in children (the acute form only); but with this exception it is distinctly a disease of advancing age. In many instances no definite cause can be found; in a large proportion there is a family history of gout, rheumatism, or both together. Constant exposure to cold and wet undoubtedly brings it on, and partly from this, partly because there is a hereditary tendency to it, it is much more common in certain countries than in others. Sometimes, especially in the hip, it occurs very rapidly after injury. Its symptoms in certain cases are so severe and the pain so great that it may easily be mistaken for acute rheumatic fever; in others it appears to be a sequela of this disease. Finally a peculiar variety of it, associated with very definite clinical symptoms, occasionally breaks out suddenly in the course of certain affections of the nervous system, chiefly locomotor ataxy.

*Acute Osteo-arthritis.*—This form is distinguished from the others by the severity of the symptoms and the rapidity of its onset. It is more common in women than in men, and may appear at any age, even in childhood. The most striking feature is the extreme degree of rigidity it leaves. The fibrous structures of the parts chiefly involved; there is very little eburnation, and it is not usual to find much marginal hypertrophy; the synovial membrane is velvety and thickened; there is no excess of fluid; the cartilage is thinned and eroded in places; but the capsule, ligaments, and all the connective tissue around are welded together into such a rigid mass that there is scarcely any possibility of movement. In some cases the ends of the bones are displaced as well; in others the rigidity is made worse by the degeneration of the muscles, which become converted into fibrous cords.

This condition, or one resembling it so closely that it cannot be distinguished, is met with under very varied circumstances. It is most common in young women, and can sometimes be traced to menstrual irregularity; not unfrequently, especially when there is a strong family history of gout, it is assigned to exposure, to cold, or to wet; sometimes it does not set in until the climacteric; and I have known an exceedingly severe form occur from catching cold three weeks after parturition. Puerperal arthritis, scarlatinal rheumatism, and acute rheumatic fever are all of them occasionally followed by it, convalescence progressing up to a certain point, and then fresh and even more persistent trouble making its appearance; and at times it breaks out suddenly with a severity only equaled by that of rheumatic fever, without it being possible to assign a reason.

The larger joints are usually the ones attacked, often several of them at the

same time; but there is no tendency for the inflammation to fly from one to the other, as it does in rheumatic fever. The affected parts are exceedingly painful; there is a considerable degree of swelling, but round the joint rather than in it; the skin is hot and red; there is great tenderness on pressure, very often for some distance above and below; and the least attempt at movement is checked by the muscles at once. The constitutional disturbance is not very severe; that is to say, the fever is not very high; and the profuse sweating and the tendency to involve serous structures which are so characteristic of rheumatic fever are rarely present. As the inflammation decreases, the swelling subsides; the tissues begin to waste; and the ends of the bones and the rigid tendons and muscles stand out prominently under the skin. Relapses and apparent convalescence, often lasting for years before it is real, are the rule.

The treatment of this affection is very unsatisfactory. If there is a distinctly gouty history small doses of colchicum with alkalies and iodide of potash may be tried; guaiacum is entirely useless and salicylate of soda seems to have but little real effect. The anæmia, which always accompanies it, and which often persists afterward, should be treated with iron, cod-liver oil, quinine, and arsenic. During the acute stage the diet must be restricted, but afterward it should be nourishing without being too rich. Whatever precautions are taken, more or less rigidity is sure to be left, so that it is absolutely necessary to keep the limbs in proper position by means of splints from the very first. Pressure and cold may be used to limit the amount of exudation, opium and belladonna to relieve the pain; later when the acute stage has subsided, counter-irritation, especially flying blisters applied every two or three days to different parts of the joint, massage, warm douching, and prolonged hot-baths are of the greatest service. Galvanism has undoubtedly some influence in maintaining the nutrition of the muscles, and may be used for this. Afterward, when the inflammation has altogether disappeared and the joints are left rigid, wasted, and more or less ankylosed, an attempt may be made by means of tenotony, passive motion, and breaking down the adhesions to restore them to something like their normal condition.

*Chronic Osteo-arthritis.*—This exists in many forms, but they are all peculiarly insidious in their onset, and as a rule steadily progressive, although now and then their course is interrupted by a subacute attack.

One of the most common begins in the smaller articulations, usually rather late in adult life, and spreads gradually from them to the larger. It is more frequent in women than in men, is always polyarticular from the first and often symmetrical. The changes are characteristic. There is an enlargement and flattening of the knuckles and the phalangeal joints, and the fingers are deflected and the movements limited. Then, by degrees, the larger articulations are attacked and more or less crippled by changes in the shape of the ends of the bones. The hand, for example, is flexed and pronated; the hip flexed and adducted; and the knee flexed, and sometimes displaced backward as well by the persistent contraction of the hamstrings. Even the spine and the lower jaw finally become involved. Lips are thrown out round the margins of the joints; the capsule becomes thickened and rigid in places, thin and yielding in others; and where the synovial membrane is superficial, as round the patella, irregularly shaped villous outgrowths can be felt gliding on the cartilaginous surface beneath as the joint is flexed and extended.

Minor degrees of this, sometimes causing considerable deformity, are of common occurrence in old people, often without their being aware of it. It seems to be in them rather a result of degeneration, and the change is so gradual, and the stiffness comes on so slowly, that they seldom notice one or the other. In young patients the course is usually more broken and varied from time to time by subacute attacks, each of which leaves the condition of the joint rather worse than it was before. The affected part is hot and swollen; the skin is red and rather glazed; the muscles are in a state of rigid contraction; and movement is attended with a considerable degree of pain. After a while this subsides and the effusion

partly absorbed, but the change in the shape of the articular surface persists; the synovial fringes that have grown during the inflammatory period and the marginal lips and bosses do not disappear; the range of movement is limited partly by the tension of the capsule and the fibroid degeneration of the muscles, partly by the premature locking of the enlarged ends; and creaking, grating, and crackling of the most varied description can be felt and heard whenever there is the least change of position. In the intervals between these attacks the patient is fairly comfortable; stiffness in the morning on getting up, or after prolonged rest, is very common, but this usually wears off in the course of the day, so far as the distortion of the articular surface will allow. Pain is rarely severe, although not unfrequently there is a great deal of aching at night or in cold and damp weather. Every indiscretion in diet is resented at once, but there is no fever or impairment of health other than that occasioned by the inability to take active exercise.

In other cases this disease is distinguished by an enormous collection of fluid in the synovial cavity. This variety is more common in the knee than elsewhere, but it may affect any of the larger joints. In its most chronic form, in which there is simple distention with stretching of the capsule and ligaments, until the bones are forced far away from each other and fluctuation can be felt in every direction, it is known as *hydrops articuli* or *hydrarthrosis*; there is no increased vascularity; the synovial membrane is slightly thickened and opaque, often rather yellow in color; the cartilages are a little fibrillated and thinned, and the bones are lipped to a certain extent, but the cavity may be large enough to hold two or three pints of fluid. In some cases the synovial membrane is perfectly smooth; in most, however, it is covered with rough, shaggy growths, containing nodules of cartilage, and sometimes the interior resembles a coarse sheep-skin mat rather than the lining membrane of a joint.

This form of osteo-arthritis is frequently complicated with the presence of synovial cysts, which may originate *de novo* as protrusions of the lining membrane of the joint between some of the thicker fasciculi, or may be developed from bursæ. The most common is the one that protrudes between the inner head of the gastrocnemius and the semi-membranosus, and forms a swelling on the inner side of the popliteal space, tense and hard when the limb is extended, but so soft that it can scarcely be detected in flexion; they may, however, develop almost anywhere, at any weak part of the capsule, and in any number.

In the majority of cases osteo-arthritis is polyarticular, but sometimes, especially where the hip is concerned, it remains limited, or almost limited, to one joint for years. The bone is the part chiefly affected, the ligaments waste and the capsule becomes rigid; but these changes are very slight in comparison. The neck of the femur may be completely absorbed; the head replaced by a growth of bone springing from just above the lesser trochanter; lips and processes thrown out to such an extent that movement is almost impossible, and the acetabulum enlarged to twice its natural size. The limb is wasted, shortened, and so stiff that it can scarcely be bent at the hip at all; it is the seat of a constant wearing pain; when any attempt is made to use the joint the grating can often be heard some distance away, and the lameness may be so extreme as to disable the patient. This particular variety is most common in old age (whence its name, *malum coxæ senile*), but it sometimes occurs in young subjects after a severe fall upon the trochanter and then is exceedingly rapid. I have known it already far advanced as early as nineteen; the limb, within a twelvemonth of the accident, had become atrophied until it was scarcely half the circumference of its fellow; it was an inch and a half shorter, and was everted and fixed to such an extent that it could scarcely be moved; and all this had taken place without any definite family history of gout or rheumatism, or any evidence of such an affection in the other joint. In connection with this particular form, it is of great importance to note that the appearance of the limb is practically the same as that of impacted fracture through the base of the neck; but if a definite history of gradually increasing disability can be obtained, there is very little difficulty in distinguishing one from

the other. Similar changes have been known to occur in the case of the humerus, but they are very rare in comparison.

**Treatment.**—At the commencement, before the effusion has become organized and definite changes have been produced in the structure of the joint, the treatment of osteo-arthritis may be attended with very satisfactory results. Afterward little can be done beyond trying to preserve the movement of the part as far as possible and to prevent any further outbreak.

The clothing, not only for the joint itself, but for the whole body, should be light but warm; cold and damp are particularly to be avoided. The diet should be carefully regulated; sugar, excess of meat, and alcohol seem especially injurious, but in this respect each individual must be a rule for himself. The bowels should be kept regular; the skin should be made to act freely; a Turkish bath may be taken now and then; and, if possible, a residence in a suitable climate should be selected.

Moist heat, kept up for a considerable length of time each day, and sometimes several times a day, is very beneficial. It may easily be applied to most joints by means of a local vapor-bath; where this is not practicable, flannel, or spongio-piline, wrung out of water as hot as can be borne and covered with oiled silk, may be tried. Greater effect may be produced by combining this with counter-irritants, especially turpentine and tincture of iodine. Flying blisters frequently repeated, hot douches, shampooing, and massage applied every other day, are especially beneficial toward the end of the attacks, when a certain amount of grating and creaking can be felt, and the muscles are beginning to waste. Galvanism may be used at the same time, and passive motion should be carefully and methodically carried out. Nothing is so likely to permanently stiffen a joint affected with osteo-arthritis as prolonged rest.

Iron and quinine are very often required, as in many cases the health fails to a very serious extent; sometimes arsenic agrees exceedingly well, the appetite returning and the strength improving almost at once. Iodide of potash seems to have little real influence, and is sometimes injurious from the depression it causes. Alkalies and colchicum may be tried, especially if there is a strong tendency to gout, but otherwise they are of little avail; and the same may be said of salicylate of soda; sometimes it is beneficial just at first, but this does not last long.

Constitutional treatment, in short, can do little more than maintain the general nutrition and check the tendency to recurrence.

When the effusion in the joint is excessive in amount, an attempt may be made to reduce it by means of counter-irritation and pressure. If this fails, aspiration may be tried, or the injection of tincture of iodine, diluted with equal parts of water. Every precaution must of course be adopted to avoid getting too severe a reaction; the limb must be kept upon a splint, well raised and bandaged, and an ice-bag must be laid over the joint. More frequently the reaction either is not sufficient to excite absorption, or fails altogether; the synovial membrane seems entirely callous. In such a case as this, if the patient is young, requiring to lead an active life, and is incapacitated by the condition of the joint, it may be laid open freely (under proper precautions), some of the redundant synovial tissue excised, the rest scraped out to a certain extent, and then, after the hemorrhage has been stopped, it may be drained thoroughly, well packed, and placed upon a splint, as after the operation of arthrectomy. The measure is a severe one, and should not be adopted unless the patient is in a perfect state of health, but it has been followed by conspicuous success.

Outlying cysts and diverticula are to be treated on the same principles. It is impossible in the majority of cases to prove that they do not communicate with the joint, and accordingly they must always be given the benefit of the doubt. Sometimes, but very rarely, they are absorbed under the influence of counter-irritants, and cause no further trouble. More frequently they can be prevented from increasing by means of suitably arranged pressure. If this fails, aspiration

e tried first; but if, in spite of this, the cyst persistently enlarges, causing us degree of weakening, and practically disabling the patient, it should be d. I have performed this operation on several occasions at the knee, ing the bursa which projects between the inner head of the gastrocnemius e semi-membranosus, and stitching up the neck of the communication with ; and the result has been very satisfactory. Unfortunately, in many of the in which cysts form, the disease is so extensive that this is practically out of estion.

## Charcot's Disease.

The most peculiar form of osteo-arthritis is that which occurs in association affections of the nervous system, especially locomotor ataxy, and which is

Fig. 245.—Shoulder Joint from a Case of Charcot's Disease.

d as Charcot's disease, from the physician who first described it. So far as general features are concerned, the pathological changes are of the same ption as those that occur in other forms of osteo-arthritis, but the rapidity which they set in, the extent to which the destruction is carried, and ully the entire absence of pain, stamp it at once as something that must by itself. What relation it bears to the ataxy is an entirely different on. When it occurs (and it is only present in a relatively small proportion) ully breaks out at an early period of the disease, when the first signs are ly marked; and I have known a typical example of it in a patient in whom time the closest investigation did not reveal anything but local anæsthesia. ar affections have been met with in other diseases and injuries of the nervous

system, though much more rarely. It has been recorded in hemiplegia, in paraplegia from Pott's disease, in poliomyelitis, and in two instances, at least, in wounds of the spinal cord; and osseous ankylosis of the finger joints has been known to follow section of the nerves of the forearm. It is not at all improbable that it is really associated with the changes in the peripheral nerves rather than with any special disease of the central nervous system, though, of course, if it occurs in connection with the one, it may also occur in connection with the other.

Whether, again, it should be regarded as a special disease, caused by impairment of nerve influence, or merely as rheumatic gout, occurring in a joint which has lost all sensation (so far as pain is concerned), and which, therefore, is very likely to be subjected to the most injurious degrees of violence, is also an open question. Pain is present, it is true, and is very acute in a small minority of cases, but, as a rule, it is soon followed by anæsthesia; and even when it does occur it does not appear to bear the same relation to the severity of the inflammation that might be expected, judging from what is usual in other forms of arthritis; it seems something altogether peculiar, dependent upon the changes taking place in the nerves themselves, rather than upon the degree of tension in the tissues of the joint. Too much reliance, therefore, must not be placed upon that. It is more important, however, that this disease has been known to occur in patients while they were confined to bed. That walking about upon a knee joint, devoid of all sensation, in which the ligaments have given way and the bones are so soft that they would literally be ground down by the least pressure, would produce very extensive changes, similar in many respects to those actually met with, may be admitted at once;

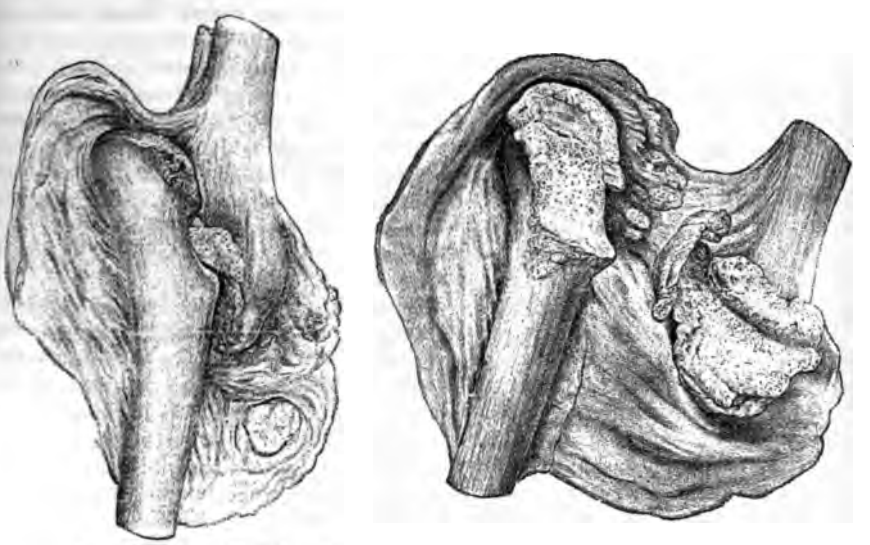
FIG. 246.—Fingers of the Same Patient.

FIG. 247.—Elbow Joint from a Case of Charcot's Disease.

but if it can be clearly established that the same effect follows sometimes when the joint is kept practically at rest, the theory that the destruction is due to the injury, as in the case of perforating ulcer, must break down. The analogy between the two cases is very distant; perforating ulcer nearly always gets well of itself if the foot is placed under favorable conditions; this form of joint disease, when it once thoroughly declared, never attempts anything of the kind. It prov

nothing, one way or the other, that the ordinary form of rheumatic gout may occur in patients suffering from locomotor ataxy.

The knee joint is affected far more frequently than any other. Suddenly, almost from one day to another, without warning of any kind, except, perhaps, a certain amount of grating, an immense swelling makes its appearance, partly due to effusion in the joint, partly to the œdema of the surrounding soft tissues. Sometimes with this there is a certain degree of fever and pain, and the skin is hot and red; but this soon subsides and suppuration very rarely occurs. The outline of the bones is completely lost, the swelling is globular, tense, and resistant, scarcely pitting on pressure; movement is attended with grating, and the joint is loose, so that the articular surfaces can be shifted in all directions; but still the patient can use it to a certain extent, especially as it is usually entirely free from pain. Then, after a time, the effusion becomes absorbed or organized, the swelling diminishes in size, and hard nodules, due to the formation of cartilage or dense fibrous tissue in the periarticular tissue, make their appearance. The articular ends of the bones disappear, the ligaments become softened or worn away; crepitus, as of two fractured surfaces, is felt when the part is manipulated; movement can take place in any direction; the leg, for example, can be extended until it lies flat upon the anterior surface of the thigh; the patient loses all power, and the most extreme distortion follows (Figs. 245, 246, and 247).



*Figs. 248 and 249.—Knee Joint from a Case of Locomotor Ataxy (Morrant Baker's case).*

The pathological changes are the same as those that take place in osteo-arthritis; there is chronic inflammation of all the tissues of the joint with atrophy, only this is extreme. The cartilages become fibrillated and disappear; the ligaments are softened and worn away; the bones are affected with rarefying osteitis, so that spontaneous fracture is not uncommon; the surrounding tissues are filled with inflammatory exudation, which sometimes becomes organized, so that osteophytes and free bodies and occasionally great lips of bone are formed; but there is rarely any eburnation, and the ends of the bones seldom show that adaptation to each other which is so common a feature of rheumatoid arthritis; the destruction is so great that they are reduced to two rounded sticks, one of which may fit to some extent in a hollow on the top of the other, but which not uncommonly simply lie side by side, so that the limb is shortened by many inches, and the joint is reduced to the condition of a flail (Figs. 248 and 249). In many instances the

amount of destruction falls far short of this; but striking examples have b recorded in which the ends of the bones have entirely disappeared, and the j been completely disorganized within six weeks.

### Tubercular Arthritis.

Tubercular infection of joints gives rise to a peculiar and characteristic for of inflammation which in all respects closely resembles that caused by the presen of tubercle in other parts of the body. It is much more common in children th in adults, although it may occur at any time of life (even old age is not exempt) it begins in the most insidious way; sometimes there is a distinct history of injury more often nothing definite can be ascertained; occasionally every such cause ca be positively excluded, as when, for example, a child lying in bed with caries o the spine is found to have developed disease of the hip; its progress is exceedingly slow, and although it may subside at any time, the tendency is to run on to th formation of a lowly organized granulation tissue, which, as it spreads wider and wider, gradually undergoes caseous degeneration in the centre, breaks down, and liquefies, forming what is known as a caseous abscess. It is identical with what was formerly described as strumous or scrofulous synovitis and arthritis. The general resemblance between the clinical characters and the main pathological features of strumous disease of joints and tubercular affection of other organs had long been organized; it was well known that they often occurred together; that the same circumstances favored their development; that caseous foci were present in both, and that in many cases of primary joint disease the lungs and other organs become affected later with typical miliary tubercle; but it was not until the discovery and cultivation of the tubercle bacillus that the identity was established and confirmed beyond all question by experiment.

The inflammation either begins in the synovial membrane or the bone; cartilage and ligament are probably never involved first. The bacillus enters the body through the mucous membrane of the alimentary canal or of the respiratory tract, rarely through a wound. Sometimes apparently it is arrested in the lymphatic glands and retained until its vitality is lost; in other instances it passes through them, or infects them one after the other until it gains the larger trunks and enters the blood stream; or again it merely causes a local inflammation, which is scarcely noticed, so slight are the symptoms, until some trivial injury wakes it into life, and perhaps, by rupturing some of the small vessels, forces the caseous mass at once into the general circulation. In any case it is brought at length to the more vascular parts of the joint where the blood-stream is quickest and where, owing to the rapidity of their growth, the tissues are least capable of resisting its influence.

Even then its action may be averted. If the dose is small and if the tissues are healthy, there is no doubt that very often the germ is either destroyed or encapsuled, or got rid of in some other way, so that no harm results. The younger the patient and the younger the tissue the greater the danger; and if, either from some hereditary or acquired cause, the nutrition of the part is feeble; or if, from some recent injury, there is an extravasation of blood, surrounded by a mass recently formed granulation tissue, the bacilli may continue to grow and spread wider and wider, until at length a group of miliary tubercles is formed and caseation sets in. In children the synovial membrane and the growing portions of the bone are involved with nearly equal frequency, so that in them primary tubercular synovitis is as common, or nearly as common, as tubercular articular osteitis; in adults, on the other hand, in whom the bones have attained their full development and have lost their embryonic tissue, the former is much more common than the latter. Injury, although it is not essential, must be regarded as a very decided predisposing cause, not only from the hyperæmia that attends it, but because the inflammation that follows lowers the vitality of the tissues and renders them less

ble of resistance. The same may be said of the exposure to cold and wet and exhaustion which are not unfrequently considered the starting-points of a distinctly tubercular affection.

**Pathological Appearances.**—(*a*) The changes that take place in the synovial membrane are the same, whether the inflammation begins in it or spreads to it from the bone, although of course in the latter they make their appearance later and are to a certain extent masked by the rest.

The softer and more vascular parts, such, for example, as the folds in the interior of the knee joint, are affected first. The endothelium is detached; the surface loses its glistening appearance; the areolar tissue becomes soft and melts away; lymph pours through the walls of the vessels and the exudation increases, until at length the membrane is replaced by a soft, gelatinous, pinkish-gray mass of granulation tissue many times as thick, and very ill supplied with blood. In this, typical miliary tubercles may be found here and there, and, though often only after a long search, tubercle bacilli. As the exudation becomes more abundant it forces its way between the surrounding structures in all directions. It grows into the cavity until this is nearly obliterated; it spreads on the surface of the cartilages, eating them out in little circular pits, until the bone beneath is

FIG. 250.—Femur, showing the Commencement of Tubercular Disease under the Neck of the Bone on the Upper Surface of Diaphysis.

FIG. 251.—Tibia, showing Tubercular Disease advancing from the Epiphysial Line, round the Edge of the Epiphysis to the Under Surface of the Articular Cartilage, which it is gradually eroding.

exposed, to be attacked in turn; and it works its way through the capsule, and spreads in the loose tissue around, until the shape of the synovial sac is entirely lost, and the swelling is perfectly uniform in outline and consistence. In some cases the joint is surrounded by a mass of this gelatinous tissue upward of an inch and a half in thickness.

As time passes further changes make their appearance. The fluid in the interior loses its synovial character, and becomes more and more turbid until at length it resembles pus. The dense fibrous tissue of the capsule and ligaments become infiltrated with the growth and softened, so that the ends of the bones are no longer held together, and displacement follows. Caseation occurs in the thickness of the granulation tissue; and finally liquefaction takes place. Sometimes the abscess, as it is usually called, points on the exterior and bursts, leaving a sinus guarded at the orifice by a mass of pale, flabby granulations, and leading down into the thickness of the gelatinous tissue; sometimes it opens into the joint as well, and after a while suppurative arthritis is added to the rest.

(*b*) When the inflammation begins in the bone, the pathological appearances are somewhat different. It may start in the epiphysis or on the articular surface of the diaphysis (Fig. 250); but invariably it attacks the part where growth is

later, and then liquefaction; sometii portions of bone or even whole bones tions without any abscess ever being fo

In other cases the inflammation is shape are formed, the base covered w the centre of the epiphysis; suppur structive arthritis is soon added to the by Koenig, these cases are due to em set free from some distant focus and until it becomes impacted, and the v (Fig. 252).

In the later stages, and after sup same, wherever the disease commenced sloughing or absorption; the bones a fragments are present here and there ments are destroyed, so that displacem synovial membrane, the capsule, and t soft, gelatinous mass, in which a few fi debris and pus.

**Repair.**—Repair and organizati stage, and it rarely happens, even in th (*a*) Before caseation has taken place cular masses are either absorbed or enc in the bone, a ring of sclerosis, forms a again by injury or some other accident of life, and gradually undergo degen weakness behind.

If, however, the disease is more w the synovial membrane is involved, or such perfect repair can scarcely take and the tissues are better nourished and be saved, stiffened to a certain extent around and inside it. Such cases are n that the tuberculous tendency, when th tion. As puberty is reached and the

void, and the disease comes to an end; but the chances of this are much more remote.

(*c*) If suppurative arthritis follows, recovery without ankylosis is practically out of the question: generally it is osseous; the cartilages are destroyed, the granulations that spring from the ends of the bones gradually obliterate the synovial cavity and are converted into bone. Sometimes, however, it remains fibrous, and a certain though very limited degree of mobility is allowed. The rest of the limb in these cases usually suffers very severely; the growth is checked, the muscles are wasted, the skin is riddled with sinuses or disfigured by deep sunken cicatrices; residual abscesses occur from time to time in the old scar tissue, and often there is great deformity from the displacement or dislocation of the ends of the bones.

Hectic and amyloid degeneration may occur as complications at a later period, brought on by the profuse and continuous suppuration. Phthisis is rare, but tubercular meningitis is not at all uncommon. It may occur at any period of the disease, but in the majority of cases it breaks out either at the commencement of suppuration or when the caseous foci and the granulations surrounding them are disturbed by some accidental violence, such as over-exertion, or by operation. The frequency of its occurrence is one of the main arguments for the free and early removal of the caseous mass, even if it involves excision, as it nearly always does in the case of the hip.

**Symptoms.**—Pain, heat, and swelling are always present, although they vary very much in degree; the skin is never red, unless suppuration has taken place; on the contrary, owing to the way in which it is stretched by the exudation beneath, it is not unfrequently peculiarly white and marked with enlarged cutaneous veins—whence the name, *tumor albus* or *white swelling*, often given to this form of joint disease.

*The pain* is very variable. When the inflammation begins in the bone, it is often an early symptom, and, like all bone pain, is worse at night and after exertion. Moreover, under these conditions, starting-pains soon make their appearance, and the bone is often exceedingly tender on pressure. On the other hand, in tubercular synovitis, it may be entirely wanting, and the joint may attain a very considerable size, and even displacement occur from softening of the ligaments, without there ever having been more than a transient complaint.

*Increased temperature* is much more constant, although the rise may be very slight, and, especially in the case of a deeply-buried joint, such as the hip, very difficult to estimate. Great care must be taken, in examining the two limbs, that exactly the same spots are compared, that they are both exposed the same length of time, and that one has not been unduly manipulated.

*The character and situation of the swelling* are most important. In tubercular synovitis it causes a soft uniform enlargement of all the superficial parts, so that the bony prominences are concealed and the outline of the limb is even and rounded. At the knee there is at first merely a slight fullness on either side of the ligamentum patellæ; then the hollows by the side of the patella are filled up, and the subcrural pouch is converted into a soft, rounded mass, which stands out all the more prominently from the wasting of the quadriceps above. In the elbow, the swelling shows itself first on either side of the triceps tendon, and in the ankle by the tendo-Achillis. In the hip it is much more difficult to estimate, but by flexing and abducting the thigh as far as the patient will allow, the hollow of Scarpa's triangle can be mapped out distinctly and the least elevation detected. There is no increase in the amount of fluid; the swelling is soft, elastic, perfectly uniform in consistence, and conceals every bony projection and every prominent ligament and tendon.

In articular osetitis, on the other hand, at least in the early period before the joint cavity is involved, the shape is much less uniform. The swelling does not follow the outline of the synovial sac; it spreads up over the periosteal surface of one of the bones; and very often it is limited or nearly so to one side of the

joint; moreover, it is firmer and more uneven in consistence, and not unfrequ it is exceedingly tender.

*Impairment of the function of the part* is one of the earliest signs. The r of movement is restricted, leading in the lower extremity to lameness. Flex is more free than extension, but neither is allowed to its full limit; and as disease advances this becomes much more marked. The position of the limb altered; the hip is flexed and adducted; the knee flexed and rotated out; ankle more or less extended; and, especially in the case of the two former, t movement may in the later stages of the disease be carried to its utmost limi At first, the flexed position is assumed voluntarily as that which gives the great ease; but afterward it is kept up and exaggerated by the spasmodic contraction the flexor muscles; and ultimately, when the ligaments are softened and th articular surfaces worn away, it ends, if left to itself, in pathological displacement and dislocation.

*Muscular wasting or loss of tone* is rarely absent. Usually it affects the extensors; thus the flattening of the buttock is one of the earliest, and, because it cannot be imitated, one of the most valuable signs of hip-disease; but it may involve all the muscles of the limb, so as to cause a diminution in the general circumference. In the shoulder, the deltoid and supraspinatus suffer first; in the knee, the quadriceps; and in the ankle the muscles of the calf.

*The constitutional symptoms* at the beginning are very insignificant. Later, when starting-pains make their appearance, and when the synovial swelling increases in size, there is a certain degree of fever, especially of an evening, the appetite fails, and health and strength begin to give way. If the case is left to itself, and abscesses are allowed to form and break, the downward progress become more and more rapid. The patient is worn out by the constant pain and want o sleep; there is a continuous and often profuse discharge of pus from the sinuse round the joint; the temperature is constantly above normal; night-sweats se in in a very large proportion of cases; and the patient sinks from hectic o amyloid disease, or else tubercular deposits make their appearance in other organs

**Diagnosis.**—The diagnosis of tubercular arthritis in the early stages of th disease is often a matter of the greatest difficulty; the swelling may be of the mos insignificant character; the pain very doubtful (and especially in the case o children often stigmatized as merely growing pains); and the temperature scarcel raised; but these symptoms and muscular wasting very rarely fail altogether. I is distinguished from all other forms of arthritis by the peculiar insidiousness o its attack and by its obstinate tendency. It is much more common in the young than in the old, but it may appear at any period. Even when it starts from a injury, it does not, like ordinary traumatic synovitis, follow at once; it may b months before anything definite is found; and it very rarely happens that it i possible to assign even an approximate date for its commencement. If othe symptoms of scrofula are present (chronic glandular enlargement, for exampl obstinate pulmonary or nasal catarrh, or persistent dermatitis), the probability no doubt very much greater; and the same may be said when either there is distinct family history of tuberculosis, or when the aspect of the patient is su as to suggest the peculiar diathesis that predisposes to it; but, beyond all que tion, tubercular arthritis (though, of course, unless it is due to a wound, it m be a secondary affection, spreading from some other part of the body) may occ in the absence of any other sign of such a disease, and without any manifest pr disposition to it.

**Prognosis.**—Many things have to be taken into consideration in the pro nosis of tubercular arthritis. The family history, the evidence of a special diath sis, and particularly the presence of any other scrofulous or tubercular affecti are of very great importance. The more distinct and well-defined the excitin cause the better; those cases are peculiarly ill-omened in which, while the patie is confined to bed, one of the joints becomes affected without it being possit to assign a reason. The period of the disease again is of very material influenc

is much better hope before caseation has commenced; if suppuration has occurred, recovery is not only more doubtful, and the tendency to secondary complications much greater, but the prognosis, so far as the joint is concerned, is very decidedly worse; more or less ankylosis must follow. A great deal depends upon the circumstances of the patient, whether he can afford the necessary time and the necessary treatment. The statistics drawn from private practice, and as Howard Marsh has shown, from institutions in which an unlimited stay is allowed, are entirely different from those of general hospitals, into which patients can only be admitted for a short time, until the severity of the immediate symptoms has subsided. Fortunately, tuberculosis of joints is in most cases a disease of early life; as puberty approaches, the tendency to chronic inflammation and caseation subsides; and even though the disease has reached an advanced stage, and suppuration has occurred, the sinuses not unfrequently dry up, the carious bone becomes dense again, the granulation tissue becomes organized, and the joint is left distorted, misshapen, seamed with cicatrices, and permanently ankylosed, but safe, under all ordinary conditions, for the rest of life.

### *Senile Tuberculosis.*

During adult life tubercular arthritis is not a common affection, although instances of it may be met with every now and then, originating in the synovial membrane. After sixty years of age, Paget has shown that the bones, joints, lymphatic glands, testicles, and other structures which appear to be the seat of election of scrofula in the young, again become liable to a similar affection. In all probability, this is due to a local tuberculosis, in the same way as the ordinary strumous or scrofulous joint disease of childhood; certainly it is in a very large proportion of the cases. There is the same insidious beginning, the same soft, pulpy swelling around the joint, leading to the smooth, uniform enlargement characteristic of tuberculous synovitis; there is the same tendency to softening of the ligaments and displacement of the ends of the bones, but, as might be expected from the diminished reparative power of the tissues, the risk of suppuration and destruction is very much greater. Abscesses form at an early period, and discharge themselves externally, leaving sinuses lined and covered with pale, flabby granulations; the cartilages slough, the bones become exposed and carious, so that a probe introduced into one of the sinuses sinks deeply into their substance, and in a very short time, compared with what takes place in young subjects, the joint is hopelessly disorganized.

**Treatment.**—The general treatment of tubercular arthritis, so far as the early stages of the disease are concerned, is perfectly definite. There is no doubt it is parasitic in its origin, and everything is good that tends to increase the resisting power of the tissues or check the growth of the infection. If only sufficient time can be gained, and maturity reached, without the disease have extended too far, there is every hope of recovery.

Good food, fresh air (preferably at the seaside), cod-liver oil, iron, quinine, tonics, etc., are the chief hope for improving the general nutrition. Absolute rest, until every trace of tenderness, swelling, and muscular rigidity has departed, cold, compression, and, to a much less extent, counter-irritation, are the main local measures. Heat, and everything that tends, like use or exercise, to increase the amount of blood flowing through the part, are positively injurious. The injections of carbolic acid (which are strongly recommended by Hueter) and other germicides are of very doubtful value.* If a sufficient length of time can be given up to this treatment; if the rest is absolute, upon a splint; and if the disease is taken at a sufficiently early period, recovery without loss of health, and without stiffness of the joint, may be confidently looked forward to, in all but a few cases in which the constitutional predisposition is overpowering.

* [Injections of iodoform emulsion are sometimes of great service.]

When the disease is further advanced, especially if the joint has had a fair t and has relapsed; when the synovial membrane is obviously becoming thic and more pulpy in spite of prolonged rest under the best available circumstanc and when the persistent local pain renders it practically certain that there is a f of disease in one of the epiphyses, the question arises whether it is not advis to treat it as a locally malignant disease, lay the joint freely open, and excise whole of the affected part. This operation is known as *arthrectomy*, when o the diseased portions are removed, and as *excision* when the articular ends formally resected in accordance with the rules laid down by the anatomy of part. The former is practically limited to the knee; in the hip and ankle it almost impossible to expose the whole synovial surface, and in the elbow it do not give sufficient mobility.

That arthrectomy, where it is practicable, is to be preferred to excision, beyond question. The growth of the limb is not affected; tubercular foci ma be scraped out without interfering with the epiphyses; the length is not altered; if the disease is removed before the cartilages are seriously affected, a great degr of movement is retained; and it is practicable in the youngest children, whil excision is not. It is true that a certain amount of support is required afterwa to prevent flexion, but this is the case in excision as well.

Nor is there any doubt that in advanced disease, where there is extensive caries or necrosis, or where there are many sinuses leading down through mass of pulpy tissue to a disorganized joint, excision of a more or less formal character is advisable, practically as an alternative to amputation.

The real point at the present day is whether arthrectomy, or, failing that, excision, should be performed at an earlier period in tubercular arthritis, as an alternative to rest, as soon as caseation has made it appearance, long before the abscesses have broken externally, and the case has become complicated by the addition of suppurative arthritis.

On the one hand there is a caseous focus with the prospect of liquefaction possibly ending in suppurative arthritis or general tuberculosis, possibly, afte protracted treatment, becoming absorbed as the patient gets older, but leavin the limb withered, shortened, wasted, perhaps seamed with cicatrices, and mor or less ankylosed.

On the other we have an operation which may shorten and impair the growt of the limb, but which should, if successful, allow the patient to get about withi two or three weeks, or months at the most, and render him free for the rest of lif from the danger of tubercular infection. At the same time, it must be admitte that there is a certain, though slight risk; that there is some danger of septi arthritis; that there is a possibility of some of the caseous material being drive into the circulation during the course of the operation, and causing thereby th very ill it is intended to avoid. That this is not imaginary is proved by the fac that at least ten per cent. of the deaths after operations of this kind are due t acute miliary tuberculosis.

At present the evidence is not sufficient to settle the question one way or th other. Probably if the treatment were begun sufficiently early and carried ou sufficiently thoroughly, and for a proper length of time, it would not arise at all Unhappily, in the majority of patients that apply to hospitals the disease is fa advanced and is months old already.

Rest must certainly be tried thoroughly first. Whether, if it has failed once it should be repeated, in the hope that the patient will be able to live down th bacillus, must depend to a great extent upon the joint involved and the conditio of life. In the case of the hip, for example, unless two or three years can be give up absolutely, under the best conditions, the treatment must not be blamed for th result. Operation is certainly advisable where, as in the case of the knee, an sometimes the ankle, it is possible to clear out a caseous focus from the interior o the bone, without the articulation being seriously involved; and there is no doub that the results, so far as the healing of the wound is concerned (primary intentio

absolutely necessary) have improved immensely with greater experience as to what is required; but it has not yet been proved that the ultimate results of more extensive operations, especially in the case of the hip joint, are very far superior, either as regards mortality or utility, to those of the expectant plan, and although it is admitted that they are necessary in many cases, they cannot be recommended for general adoption.

Cold abscesses may be drained, or, if they are moderate in size, treated in the way recommended by Barker. The fluid is drawn off with a hollow needle and an emulsion of iodoform in glycerine thrown in; this, by virtue of its high specific gravity, sinks into the deepest part of the tuberculous cavities and even penetrates through the thick deposit of caseous matter. Others have employed a five per cent. solution of the same drug in ether; but care must be taken, if the abscess is of any size, not to cause iodoform poisoning.

Relapses are of common occurrence, whether tubercular arthritis is treated by prolonged rest or by operation. Some of these are true relapses, due to the death or removal of the tubercle bacilli having been incomplete, and to the conditions that favor their growth having suddenly been revived: a sprain, for example, causing slight hyperæmia, may wake into activity again the germs that are lying latent in an old tubercular joint; but not improbably, especially when they take the form of residual abscesses, many of these are merely due to the imperfectly nourished scar tissue breaking down from some accidental cause, and do not imply a return of the specific disorder.

*Arthrectomy.*—By this is understood the complete removal of all the diseased structures from a joint without interfering more than is absolutely necessary with the growth or the length of the limb. Practically it is limited to tubercular disease of the knee joint, though in exceptional cases it may be performed upon the hip or ankle. As the amount of movement retained afterward is in most cases limited (it depends, of course, upon the extent of the disease) it cannot compare with excision of the elbow or shoulder.

The line of incision varies with the locality of the disease. Where there is a distinct enlargement of one of the condyles, without the synovial membrane being much thickened, a longitudinal incision down the side of the joint is sufficient. If, on the other hand, the mischief is more extensive, the whole of the interior of the articulation must be thoroughly exposed. This may be done either by a transverse incision across the patella, the two fragments being wired together afterward; or better, by the old fashioned semicircular incision for resection, carried a little further down over the tubercle of the tibia. This projection of bone can be separated from the shaft with a stout scalpel (it is part of the epiphysis and remains for a long time cartilaginous), or if it is bony, with a chisel, and then turned upward with the patella on to the femur. A single median longitudinal incision dividing the patella vertically, does not allow the sides of the joint to be examined; but, if the disease is not far advanced, it is probable that sufficient space may be obtained by two, one on each side, without a transverse one, and without dividing the ligamentum patellæ, as recently practiced by Sendler.

As it is very important to prevent oozing after the operation, Esmarch's bandage is not used, but the limb is raised vertically for a few minutes, after Lister's plan, and the circulation controlled by an elastic tourniquet. Experiment has shown that the presence of coagula under these conditions is distinctly favorable to the development of miliary tubercle, and interferes with primary union. So far as possible the diseased structures are dissected out, cutting through the healthy tissue outside them; crushing or bruising them in the process is liable to force some of the caseous debris into the open vessels, especially where the bone is exposed. The thickened synovial membrane, for example, after the flap is reflected, is carefully dissected off the under surface, commencing at the top, and passing completely round the reflection under the crureus on to the surface of the femur. The sides are treated in the same way, the crucial and posterior ligaments being thoroughly cleaned, but, if possible, preserved intact. Sometimes a sequestrum is found and can be removed; but, as a rule, if the bones are involved, a gouge must be used to

scoop out the soft caseous material and the infiltrated cancellous tissue around. For this Barker recommends a hollow instrument connected by a rubber tube with a reservoir, as by it the debris can be washed away from the surface of the wound at once.

After the whole interior has been thoroughly examined, the bleeding points are secured (they can easily be seen by relaxing the tourniquet for a moment), all oozing stopped by flushing the wound with a solution of iodine or corrosive sublimate in water as hot as can be borne, and the stitches inserted, a sponge being left [illegible] they are all in position. The surface may be dusted with iodoform, if it is [illegible], or brushed over with a solution of the same drug in ether. It is [illegible], perhaps on insufficient evidence, that it has some special action [illegible]. Kocher recommends, in the case of the shoulder, that [illegible] with iodoform gauze and left for three days, before the [illegible] so great is the importance of preventing extravasation and [illegible].

[illegible] although their presence necessitates the dressing [illegible] than would otherwise be necessary. The joint is carefully [illegible] dressing, the edges of the wound not being covered [illegible] through the lips [illegible] with a plaster bandage, and kept absolutely [illegible] be raised to the vertical position, [illegible] the chance of [illegible] when required, but as there should [illegible]

[illegible] the growth of the limb is complete.

[illegible]

[illegible]

[illegible] children than adults. [illegible] years of age. [illegible] of some [illegible] impossible to trace [illegible]

[illegible] almost always begins in the [illegible] the ligaments or [illegible]

[illegible]

uels enter here. In some cases, especially the more acute ones, there is a seques- m such as might be caused by tubercular embolism (Fig. 252); in others, there a layer of characteristic gray granulations spreading quietly along the growing ne, and undermining the epiphysis. Sometimes the osseous nucleus of the head almost unaffected; sometimes granulations spring up in it as well, and gradu- y eat away the articular cartilage from beneath. The trochanteric epiphysis, on e other hand, is very rarely involved.

The earlier changes are seldom seen. If the treatment is commenced at ce and carried out thoroughly, the soft granulations become organized, the bercular deposit is absorbed or encapsuled, and complete restoration takes place.

As the disease advances the synovial membrane becomes thickened, softened, d vascular, although it very rarely shows such mplete pulpy degeneration as it does in the nee. The fluid in the joint is turbid, with kes of lymph and fragments of cartilage. he firm, fibrous parts of the capsule are fected least; the soft and delicate structures tached to the posterior intertrochanteric line, d the loose mass that fills up the cotyloid otch, suffer the most. In some cases the head f the bone is completely separated, almost changed, and lies as a loose sequestrum the interior (Fig. 253); in others, when e joint is opened the articular cartilage is nging in shreds, loosened and detached by e granulations springing from the bone be- ath; the osseous centre is eroded, carious, d greatly reduced in size (Fig. 254); and trace of ligamentum teres can be found.

FIG. 253.—Separation of Head of Femur as a Sequestrum.

The acetabulum fares no better, even when the disease is femoral from the t: the disease spreads along the synovial folds; the cartilage is partly eaten ay by the granulations springing from the femur, partly detached by those owing from the base beneath; the bone is exposed and carious; sometimes ere are sequestra here and there; and not unfrequently, especially in old, glected cases, the cavity is enlarged upward and ckward, from the pressure of the head of the bone extreme flexion.

The neck of the femur may be shortened by ries eating into it from the epiphysial surface, but usually acts as a barrier. Sometimes, however, e disease spreads down it, gradually absorbing e cancellous tissue in the interior, and replacing it a mass of caseating granulations, until at length medullary canal of the bone is reached, and onic tubercular osteomyelitis is added to the rest.

FIG. 254.—Advanced Tubercular Disease of Head of Femur, showing the extent and directions of the destruction.

Later, as the caseous deposit begins to liquefy break down, the inflammation spreads from the sule to the periosteum covering the upper part the shaft. Caseous abscesses make their appear- e around the joint; sometimes they occur inde- dently, originating in the soft and gelatinous articular tissue; sometimes they are due to the ammation in the bone working its way to the face outside the attachment of the capsule. Then skin and the tissues around become undermined; the caseous deposits extend il they either break of themselves or are opened; and true suppurative arthritis s in as well.

When this occurs, the process of destruction proceeds at a much more r rate; portions of the acetabulum undergo necrosis; the floor is perforated; l intrapelvic abscesses form; the rim is destroyed; the cup-shaped cavity is immen enlarged, especially upward and backward, the direction in which it is subject to the pressure of the femur; the cartilages disappear; the ligaments are soften and infiltrated to such an extent with the inflammatory exudation that they n longer hold the bones together; the head of the femur, if it is not already de stroyed, is detached; the neck is eaten away; and the upper end of the shaft, with the great trochanter, eroded, softened, and carious, is forced by the persistent muscular contraction through the upper and back segment of the joint, plowing its way out partly through the rim of the acetabulum, partly through the capsule, until what remains of it rests upon the dorsum of the ilium, causing *dislocation by destruction*.

It must not be forgotten that, provided the patient escape the dangers of complications and intercurrent disorders, the process of destruction may come to an end at any time, and repair gain the upper hand. Tubercular arthritis is distinctly of limited duration: after a time it ceases to spread; the granulations become partly absorbed, partly organized; the caseous masses are encapsuled or discharged externally, often leaving sinuses behind; and ankylosis, fibrous or osseous, with more or less distortion and deformity, results.

**Symptoms.**—*Limping*, caused by the rigidity of the muscles and the endeavor to save the joint as far as possible, is the first symptom noticed in most instances. The hip is never quite straightened in walking; the amount of flexion allowed is limited, so that the step is short, and very often at the same time the toes are turned out more than those of the other foot. At first it is only present, or at least noticeable, when the child is tired, and it may be painless; later, it becomes continuous and is attended with such suffering that the child can hardly rest any weight upon the affected leg.

*Pain* in the earlier stages is very variable. In chronic cases in particular it is exceedingly slight, and is often regarded as merely growing-pain, coming on after any unusual exertion. In acute ones, on the other hand, and when the bone is exposed, it may be of the most intense description, the patient sitting grasping the limb with both hands to prevent the least movement, and crying out with apprehension if any one approaches the bed. Starting pains at night are often very severe when the cartilage is partly separated from the bone on which it rests.

*The locality of the pain* is very remarkable. In a large proportion of cases it is referred to the skin on the inner side of the knee joint, sometimes to the front, and it is not an unusual thing to find that the knee has been examined time after time, painted with iodine, blistered, and even placed on a splint, while the real seat of the disease has been entirely overlooked. In other instances it is referred to the hip itself generally, or to the front of the thigh, or even to the leg; sometimes, particularly in the acetabular form, it is chiefly seated in the iliac fossa above Poupart's ligament, or over the tendon of the adductor longus. The explanation is to be found in the fact that pain, caused by irritation of a deeply seated branch of a nerve, is usually referred to one of the cutaneous divisions, just as cancer of the larynx causes pain in the ear, and a stone at the neck of the bladder gives rise to an intense cutting sensation at the end of the prepuce. The cutaneous division of the obturator is the one most often selected, because of the peculiar distribution of that nerve to the inside of the hip joint and to the ligamentum teres; but it may be referred to the middle or internal cutaneous of the anterior crural, and even to the long saphenous and the branches of the sciatic plexus. There does not appear to be any constant relation between the seat of pain and the extent or position of the disease, though when it is severe, especially at night, it may be taken as indicating that the bone is involved.

*Tenderness on pressure* is usually distinct at an early period, especially in Scarpa's triangle, just below Poupart's ligament, and behind the great trochanter—in other words, where the joint is most superficial—and in association with other

symptoms is of very great value in distinguishing hysterical affections of the hip from real. In the former, it is usually cutaneous, and often, if the attention is diverted, deep, steady pressure is well borne; in the latter this is reversed, and superficial tenderness is rarely present unless the inflammation is acute or there is commencing suppuration. Sudden jarring of the heel or knee, so as to bring the two articular surfaces smartly into contact with each other, causes pain at an early period of the disease, and should always be avoided.

*The attitude of the limb* is of very great importance. Throughout the disease, from first to last, the hip, if left to itself, is always flexed. The two legs may be placed apparently in full extension side by side upon a couch, with the knees perfectly straight, but this is due to the curving forward of the lumbar vertebræ (lordosis) in compensation, and if the hand is placed beneath the loins, the

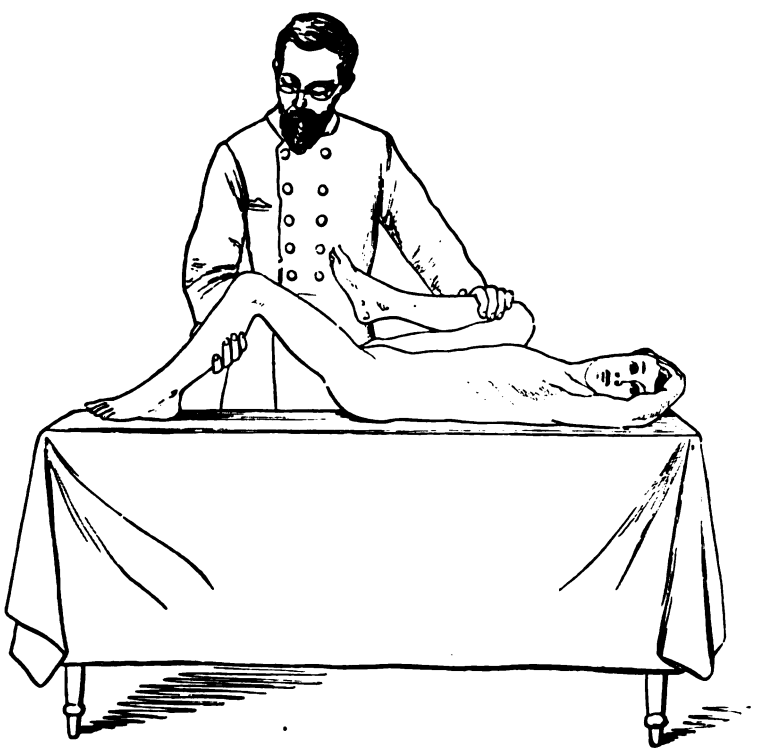


FIG. 255.

alteration can be felt at once—the back does not rest upon the couch. If now, with the hand still there, the affected limb is gently raised, the vertebral column gradually becomes straight, and the hollow disappears. The number of degrees through which the limb must be moved, in order to effect this, may be taken as the measurement of the flexion of the joint.

For purposes of diagnosis, Thomas places the patient upon a table or hard couch, flexes the sound limb until the thigh touches the abdomen and the leg the thigh, and then directs the patient to straighten out as far as possible the hip that is diseased. As the back is straight and the pelvis fixed, measurement of the angle is easy (Fig. 255).

It rarely happens, however, that the flexion is perfectly straight. In the early stages there may be a considerable degree of abduction and apparent lengthening. In the later, there is always adduction and apparent shortening; that is to say,

when the patient is lying down with the limbs parallel and extended (the p being neglected for the time), the foot of the affected side appears either lower or much higher than that of the sound one. That the alteration in l apparent only at this stage can be shown at once by examining the pelvis; t spines are raised or lowered exactly in proportion to the feet, but it is ne to make certain of this, as later, the shortening often becomes real.

The association of abduction with apparent lengthening, and adductio apparent shortening, is sufficiently obvious. The angle of lateral deviation absolutely beyond the patient's control, so that the legs, when they are plac by side, cannot be at right angles with the pelvis. If now the lower lim brought into the same straight line with the trunk, it follows as a natural quence that the pelvis must be tilted. Just as in flexion there is a corresp degree of lordosis, so in this there must be a compensatory lateral deviatio

FIG. 256.—Attitude in Early Stage of Hip-disease; the hip and knee flexed, and the heel rested.

FIG. 257.—Side View of the same.

spine. The same thing holds good, whether it is abduction or adductio the tilting is in the opposite direction (Figs. 258 and 259).

The measure of this tilting may be taken by abducting or adduct affected limb from the middle line, until a tape, stretched from the ep notch to the inner malleolus of the sound leg, passes exactly over the um showing that there is no lateral curve, and crosses at right angles anothe joins together the two anterior superior spines.

Later in the course of the disease, adduction is caused by the alter shape of the articular ends of the bones, and by their displacement or dislo and then it is always associated with real shortening. Occasionally ad of both limbs, with extreme eversion (scissor-legged deformity), is m probably, as suggested by Lucas, brought on by the patient involuntarily t his leg into the best position for progression under the circumstances.

Many reasons have been assigned for the change in the position of the limb. Flexion, as already mentioned, is present throughout. In the early while it is still slight, and associated with abduction and eversion, it is

cause it is the position of greatest ease—that which causes least tension on the muscles and ligaments and least pressure upon the head of the bone; and it has been found by experiment that this is the position in which the capacity of the hip joint for fluid is the greatest. Afterward, however, when it is combined with adduction and inversion and is carried (as it frequently is if left to itself) to such a degree that the limb is bent to an acute angle with the trunk, this holds good no longer, and the cause then is the spasmodic contraction of the flexors. Just as in the knee joint they gradually flex the leg upon the thigh until the calf is in contact with the ham, so here they overcome the extensors, and flex and adduct the thigh upon the trunk, until, if it is not checked in some way, the limb can go no further.

*Muscular wasting* affecting the extensors is one of the earliest and most valuable signs. The gluteus maximus on the affected side is flattened and feels flabby in comparison with the other; and the lower gluteal fold is partially obliterated. This atrophy is probably reflex, due, it may be, to some form of

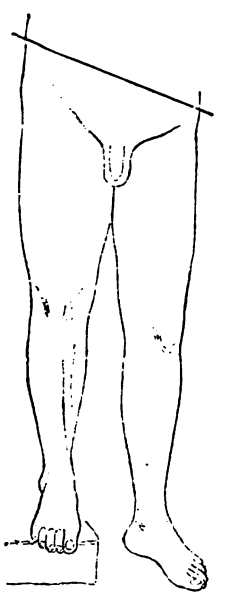


FIG. 258.—The Legs Parallel and the Pelvis tilted, because the angle of the affected limb (whether it is abducted or adducted) is fixed, and beyond the patient's control.

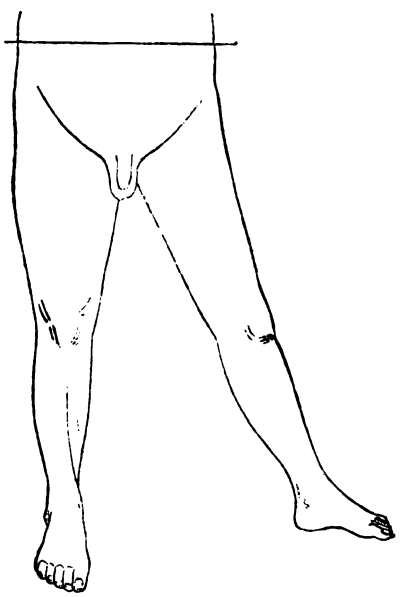


FIG. 259.—Pelvis Brought to its Proper Position by abducting the thigh on the diseased side.

descending neuritis, and must be distinguished from that form occurring later in the disease, and affecting all the muscles of the limb equally, caused by disuse.

*Impaired mobility*, which is always present from the very earliest days of the disease, is the most valuable symptom. At first it is due to muscular rigidity and spasm, and disappears completely under an anæsthetic; later it is caused by adhesions round or inside the joint, and at length in some cases by bony ankylosis. Perfect extension is impossible; apparently it may be carried out, but this is a deception, due to the lordosis. Perfect flexion is equally out of the question. If the finger is placed on the anterior superior spine of the ilium on the sound side, and the limb is flexed, taking care to keep it in a straight line with the body, without abducting it, the pelvis remains perfectly steady until the front of the thigh touches the abdomen; if the same is then done on the diseased side, the pelvis begins to rotate from under the finger, sooner or later, according to the degree of limitation. Rotation is equally important; if the thigh is flexed to a right

limb is flexed and abducted, it points to
more usually met with in rheumatic and
disease. Later it may be best appreciated
ger and thumb, from before backward.
great trochanter is almost proof of caseatic
lar tissues rarely comes on until the diseas

*Alteration in the Length of the Limb.*
have been already mentioned; they are d
Real lengthening is very doubtful. It is
creased growth of the limb; but the circu
it must not be forgotten that inequality o
The head of the femur is sometimes separa
ating itself between the two cartilaginous
may be effected by the growth of granulati
but either of these conditions would preve
and measurement taken with the least deg

Real shortening, on the other hand,
caused in various ways. In the most com
of the acetabulum, against which it is
mutually destroy each other. Pressure or
sorption and disintegration; the head of
time that it cuts away through the margin
struction, even if it does not end in a kin
able degree of shortening. In rarer cas
forated; or the head of the bone is pushe
accumulates behind it, forming what is
the epiphysis is separated from the neck,
upper and back part of the capsule of the
shortened by the loss of the epiphysis and
general failure in nutrition of the part.

A sliding-rod should always be used
and the measurements should be taken fro
ternal malleolus, but there are many source
causes a diminution in length. Owing to
of the articular surfaces, real shortening is

True suppuration is a complication and may not make its appearance so long as the skin is intact. Sooner or later, however, some caseous focus in the centre of a mass of granulations slowly softens, and becomes liquid. Usually this begins in the interior of the joint, and often in the interior of the bone; but occasionally it is periarticular from the first. The orifice in the capsule, however, is generally very small and is easily overlooked. The direction the fluid takes depends on anatomical relations. It may work its way out through the posterior thin part of the capsule behind, and point under the gluteus maximus, or pass under the transverse ligament to the inner side of the limb. Sometimes it comes out through the front, along the course of the branches of the external circumflex, or, in older patients, it opens into the bursa under the psoas. A very common situation for it to show itself is just in front of the insertion of the tensor fasciæ femoris, guided, in all probability, by the firm sheet of fibrous tissue that lies beneath it; but it may run up the sheath of the psoas or work its way into the perineum, and burst into the ischio-rectal fossa or even into the rectum. Intra-pelvic collections of this kind nearly always point to disease of the acetabulum; sometimes they originate independently on the pelvic side between the bone and the obturator fascia; in other cases they are due to perforation of the floor. Even when small their presence can usually be detected by examination with the finger in the bowel; as they enlarge they spread upward, causing a fullness in the iliac fossa over Poupart's ligament, and pointing generally near the anterior superior spine. When the disease involves the pubes, the opening is usually either by the side of the adductor longus tendon, or in the groove between the scrotum or labium and the thigh. Old cases of hip-disease very commonly present sinuses discharging a thin purulent fluid from time to time, in several of these situations.

**Constitutional Symptoms.**—In the early stage of hip disease these are very slight. Caseation and liquefaction may generally be suspected if there is definite and regular rise of temperature every evening. Later, when suppuration occurs, this is always present. Hectic, the various forms of fever caused by septic absorption from ill-drained suppurating cavities, amyloid disease, and other troubles which are not uncommonly met with at a later period still, must be regarded as complications which occur in tubercular arthritis in common with other varieties of joint disease.

**Diagnosis.**—Advanced hip disease is usually clear at the first glance: in the early stages the diagnosis is often a matter of the utmost difficulty. The symptoms are very slight; many of them are present in other affections, and worst of all, as it is necessary to prove that the joint is sound, they are often imitated with great exactness in hysteria. The examination must be thorough; no symptoms may be neglected; but the limitation of movement even in the slightest degree, the wasting of the extensors, and the position assumed by the limb, are certainly the most important.

The diagnosis must be made from other diseases of the hip joint; malformations; diseases of other joints; inflammation of neighboring structures, and hysteria.

Inflammation of the hip joint due to other causes is very rarely insidious. Rheumatic synovitis may occur in children, and requires especial care, as after a temporary improvement it becomes sometimes the starting-point of tubercular disease. Syphilitic inflammation is rare, even in the hereditary form, and probably could only be diagnosed by the result of specific treatment. Rheumatic synovitis is much more acute, and chronic rheumatoid arthritis, which does, as a rare exception, affect the hip in children, may be distinguished by the character of the articular changes

Congenital dislocation of the hip, rickets, and infantile paralysis sometimes produce a condition of things which in the absence of any history, or if the patient is hysterical, may give rise to considerable difficulty. Movement, however—especially rotation in the flexed position of the limb—is rarely restricted.

Tubercular disease of the sacro-iliac joint may present essentially the same

symptoms; in addition, however, there is always pain in attempting to separate or press together the iliac crests; and usually there is a certain amount of fullness over the joint posteriorly. Lateral curvature of the spine, which may result from disease of the hip, is occasionally mistaken for and treated as the primary affection. Mistaking disease of the hip for disease of the knee, owing to the pain in the latter, is much more common. It must not be forgotten, however, that the two may occur together.

Chronic osteitis or periostitis of the upper end of the femur is most difficult, especially as it is always associated with a certain degree of synovitis. The severity of the pain, especially at night, the great tenderness over the trochanter, and possibly the early development of œdema of the skin covering it, distinguish them, but exploratory incision is generally required. The same difficulty occurs with a rare form of central sarcoma involving the upper end of the bone.

Inflammation of the bursa under the psoas, or of the psoas itself, imitates hip disease exceedingly well, especially in young adults. The bursa, generally speaking, develops in childhood, but does not attain a very large size for some years, and rarely communicates with the joint until late in adult life. As a rule, the diagnosis can be made by the free rotation allowed when the hip joint is flexed. More rarely the same thing occurs in connection with one of the gluteal bursæ.

Perityphlitis, iliac and psoas abscesses, and inflammation in connection with the lymphatic glands, or with the cellular tissue around the hip joint, occasionally give rise to a certain amount of difficulty; but this nearly always results from special attention being paid to one single symptom. If the whole case is thoroughly and carefully investigated, such a mistake can scarcely occur.

The same may be said of hysteria: the position of the limb may be exact; the pain may be felt in the knee; there may be limitation of movement just as there is in real disease of the joint, but it rarely happens that these symptoms are in accordance with each other. Cutaneous tenderness, for example, may be excessive without there being any pain on deep-seated pressure; intra-articular pressure may be well borne when the hand is applied to the heel, but exceeding painful when the knee is touched; or there is some other gross discrepancy which effectually negatives the idea of serious disease.

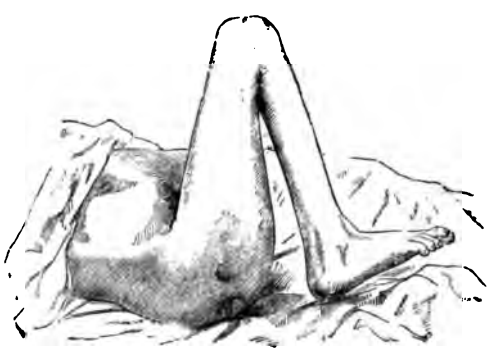


FIG. 260.—Attitude of Advanced Hip Disease.

**The Stages of Hip Disease.**—For convenience in description it is usual to divide hip disease into various periods distinguished by certain clinical features, of which the position assumed by the limb is the one usually selected.

In the first, flexion is slight, and is, or is not, accompanied by slight abduction.

In the second, flexion is well marked; abduction and apparent lengthening are present as a rule: sometimes, however, there is adduction.

In the third, flexion is combined with adduction and apparent or real shortening.

As, however, this gives little or no guidance for treatment, and as it cannot be said that the position of the limb invariably corresponds with the pathological changes, a classification closely resembling that proposed by Adams is more satisfactory.

First stage: to the beginning of caseation, without thickening of the base the trochanter or an evening rise of temperature. Perfect recovery possible, the granulation tissue being completely absorbed or organized.

**Second stage:** caseation, but no general thickening around the joint or articular infiltration. Recovery more doubtful, with great danger of relapse, the risk of general tubercular infection, and some limitation of movement.

**Third stage:** the capsule softened; the limb adducted; the shortening apparent first, but later becoming real; extra-articular suppuration; and permanent deformity with much greater risk of tuberculosis and liability to the various forms of septic infection, hectic, and amyloid disease. If the patient escapes these dangers the tubercular process may come to an end; and gradual organization take place, with the formation of residual abscesses from time to time.

**Treatment.**—The general principles are of the most simple character. Every care must be taken, by appropriate hygiene, good food, tonics, cod-liver oil, etc., to improve the general health, as already described. The first thing is to bring the limb into good position; the second to keep it absolutely at rest until it has thoroughly recovered. During the acute stage and so long as the pain is severe, the child should be confined to bed; afterward, if it can be kept under proper supervision, it may be allowed to get about on crutches, with the limb protected against movement and accident by means of a suitable apparatus. There is no doubt that the evil effects of a prolonged confinement to bed have been much exaggerated; but, on the other hand, provided the deformity is corrected, and the limb is properly secured, no purpose is served by retaining the child there during the long period of convalescence.

FIG. 261.—Bryant's Splint for Parallel Extension.

(*a*) *In the First Stage.*—The apparatus in general use is either a long splint with weight extension, or Thomas' splint; but the surgeon must be prepared to make use of others, such as Byrant's (fig. 261), or to devise them for use in exceptional cases, where, for example, there is disease of both hips or some unusual deformity.

Weight extension is advisable if the symptoms are very acute; it prevents intra-articular pressure as well as friction, and secures complete muscular relaxation. It is most easily applied by means of the ordinary stirrup, fastened above, as well as below, the knee with circular pieces of strapping and a bandage. Care must be taken that there is no pressure upon the malleoli; and that the weight is not applied for some hours after the stirrup is applied, for fear of the strapping giving way. Three or four pounds are sufficient for a child; six or eight for a young adult.

The position of the patient is secured by means of a long splint, reaching from the axilla to below the foot, applied to the sound side of the body. In the case of a child the shoulders should be fastened down by means of a chest-band and braces, so that he cannot raise himself from the recumbent position. The direction in which extension is made depends upon the attitude of the limb. If the patient is under an anæsthetic, and the hip joint is perfectly straight, showing that the deformity is purely muscular, extension—provided it is begun before the muscles regain their tone—may be made

in the axis of the body. The steady pull upon the limb, as consciousness returns, prevents the spasmodic contraction causing any pressure upon the articular surfaces. If, on the other hand, an anæsthetic is not given, if there are fibrous adhesions present, or if the muscles have degenerated and become rigid, so that

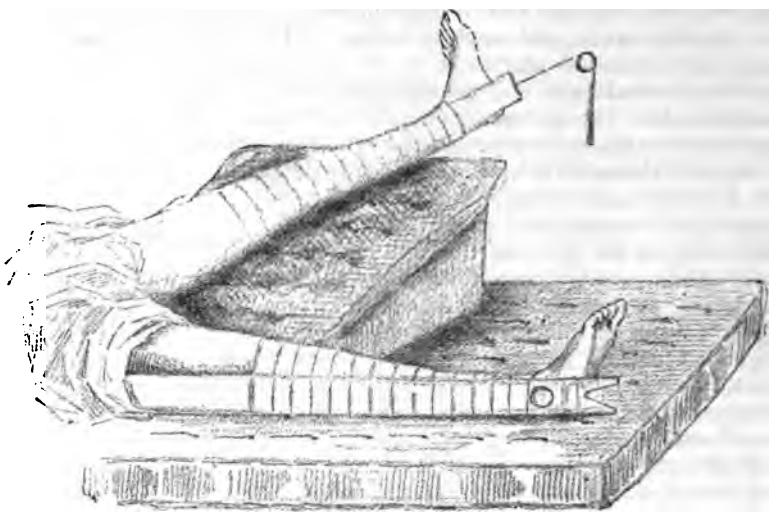


FIG. 262.—Weight Extension in the Faulty Position. Abduction and Flexion.

the limb cannot at once assume a straight position, extension must be made in the axis of the limb, and the angle gradually straightened every two or three days. In this way the opposing structures, whatever they may be, are slowly

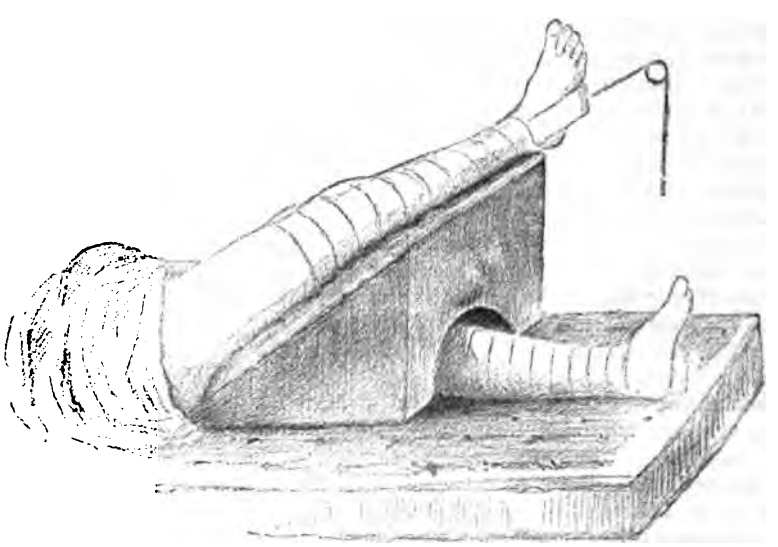


FIG. 263 —The same, but with the Limb Adducted and Flexed.

stretched until the desired length is obtained. Extension made in the straight line at once causes the pelvis to tilt either forward or to one side, according to the character of the deformity, and forces the head of the bone against the acetabulum, the resisting structures in front acting as the fulcrum of a lever.

**Flexion is generally easily remedied by this, so long as it is dependent upon** ıcular rigidity or extra-articular fibrous adhesions. Ever- ı or inversion of the foot can be cured at the same time, ıer by placing the side portions of the stirrup rather iquely upon the limb, or by adjusting to its outer side a ırt splint with a cross-piece at the bottom, which can be ıed at one end and lowered at the other until the required rrection is made. A moderate degree of abduction is t objectionable; indeed, it is to some extent beneficial, d should, for example, be maintained after excision, as, by ısing apparent lengthening, it tends to correct any real ortening; but, for the same reason, adduction is espe- ılly to be avoided. Marsh recommends that, where its tent is at all serious, counter-extension should be made ɔn the splint on the sound side of the limb in the opposite rection—that is, toward the head of the bed—so that the ılvis may be slowly twisted round. Thomas's splint, how- ʻer, is more likely to succeed.

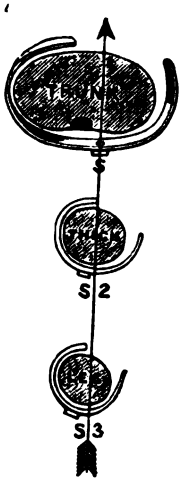


FIG. 264.—Diagrammatic sections of Trunk and Lower Extremity, showing application of hip-splint and hoops.

With regard to the length of time this treatment should ɜ maintained, no general rule can be laid down. The faulty ɔsition of the limb must be corrected, the muscular rigidity ıst disappear, and when the weight is reduced by slow de- ees, there must be no tendency to return of the flexion. It ay be many months before this takes place, and even then ıe limb must be protected by means of a Thomas's splint; the patient must be ɔntented to get about on crutches with a patten under the opposite foot; the eight should be reapplied at night, and careful atch must be kept for any return of the pain or uscular rigidity.

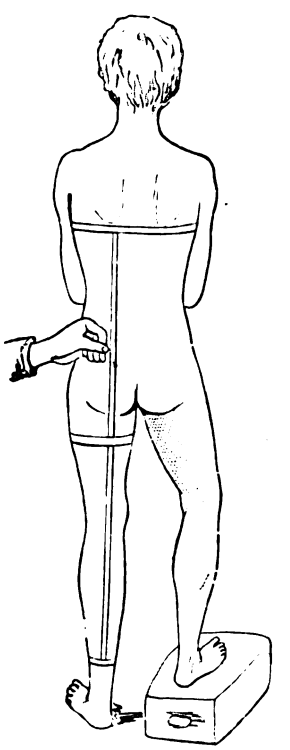


FIG. 265.—Measuring for Thomas's Splint.

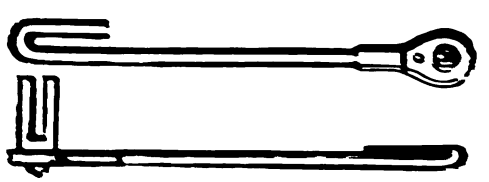
Thomas's splint, on the other hand, aims at curing muscular relaxation, not by extension, but nply by rendering the joint absolutely rigid. The uscles are in a state of spasm, because the least ɔvement causes pain; if the joint is fixed so that ɔtion is impossible, they relax of themselves and ow the limb to become straight. The only ex- ıding force is the weight of the part, and this, even en there are fibrous adhesions round the joint, generally sufficient to correct the deformity hout having recourse to other measures. In the ıds of the inventor (who uses it for all stages of disease) it has proved most successful, but it is no means easy to apply properly and effectually; surgeon must be able to manipulate it himself, ł adapt it constantly to the varying circumstances ɛach patient; and this cannot be done without ısiderable experience.

It consists of a flattened bar of malleable iron, ficiently strong to bear the weight of the patient hout bending, and long enough to reach from the ;le of the scapula to below the calf. This is bent ıs to fit in the lumbar region, just external to the terior superior spine, curve forward under the teal fold, and run down the leg slightly to the er side of its middle line. In addition, it is htly twisted on its long axis in the gluteal region, that while the lumbar portion looks forward and inward, the lower half is

directed slightly outward; the extent of this twist varies with the build of the patient, and must be increased if the splint has any tendency to shift away from the spine. On this are riveted three metal hoops, one round the chest, the second round the thigh just below the gluteal fold, and the third round the calf, the first equal to five-sixths of the circumference, the other two about two-thirds at their respective sites. These are not fastened in the centre, but rather to one side, so that one arm is longer than the other; that is to say, if the right hip is affected, the left arms of the three hoops are the longer, reaching to almost the middle line, and cling closely to the skin; the right ones are shorter, and somewhat set away. The upper crescent is closed round the chest by means of a strap and buckle and the splint is fixed to the chest and to the limb by means of two flannel bandages.

The age and sex of the patient, the side that is affected, and any peculiarities as regards position must be noted. The chief measurements are the circumference of the body at the nipple-line; of the thigh, two inches below the gluteal fold; and of the leg below the calf; and the length from the nipple-line to the same two places.

In every case the splint should be modeled to the sound side of the body, no matter how great may be the degree of flexion. Padding should be used freely to fill up the hollow under the loins and in the bend of the knee, so that the patient may rest comfortably upon the bar: gradually, as the cotton-wool gives way and becomes compressed, the body and limb sink with it, and straighten themselves out. Of course, if the deformity is considerable, the hoop that goes round the thigh cannot be closed at first, and its sides may even require to be prolonged: and care must be taken to prevent the back of the heel resting upon the lowermost hoop. Slight alterations of this kind can be easily effected by wrenches, but it is seldom practicable to bend the main support of the splint so as to fit the limb without injuring it more or



No. 10. Thomas's Wrenches for Altering Splint.

less, and it is not necessary. The splint answers quite as well if it is modeled to the sound side of the body from the first.

[illegible] Long Splint.

[illegible] the method of application of the splint and [illegible] when it is used in the hospital; the

ently to place it in position; and the strap of the body-
e chest, care being taken that the buttock rests well in
ges are required; one broad, for the body; the other
ach case they must be fastened to the splint first. The
cal bar well toward the spine; the operator stands upon
end of the bandage first under the splint, then between
leaving an end sufficiently long to be firm), and then
om below upward. The direction of the other depends
rsion of the limb, the turns being made to correct the
ole. While it is being applied, the foot should be held
natural position. The whole splint is prevented from
f a brace over the shoulder; if there is abduction, it is
ide, if adduction on the sound one. So long as the
atient is confined to bed, and he should not be allowed
and back are perfectly straight.
nity is at all serious a double splint should be used, the
nnected together so as to ensure complete rigidity.

FIG. 268.—Thomas's Hip-splint Arranged for Walking, with Crutches and Patten under Foot on Sound Side.

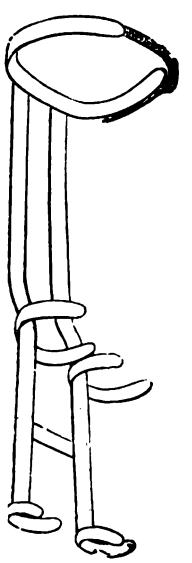


FIG. 269.—Double Thomas's Splint.

nakes its appearance, it may be abandoned altogether,

the child simply getting about with a patten and crutches; but the majori require it for one or two years at least, and, if the disease was at all advan before applying for treatment, sometimes for very much longer.

(*b*) *Second Stage.*—If, when the case is first seen, there is distinct thicken round the base of the great trochanter, with a regular rise of temperature of evening, or if prolonged rest has been tried without success or with only a sli degree of improvement, and that of a temporary character, it becomes a ques whether it would not be advisable to remove the whole tubercular focus, or, other words, perform excision, instead of waiting for the time when the dise will cease to extend. A further trial should certainly be made if the circumstanc under which the patient is placed are favorable, if, for example, two or three ye can be given up, in the hope that as the patient grows older the tendency wi cease and organization take place; but if this is not possible, the more activ treatment is the better. In any case the limb will be more or less crippled an ankylosed, and it is better to remove the whole source of disease at once (provided primary union is ensured), even if a little more than is absolutely necessary is taken away, than to leave it to certain suppuration and destructive arthritis, in the hope that the pus, after it has burrowed outside the joint and undermined the surrounding tissues for two or three years, will carry away all the tuberculous material and gradually dry up.

Acute abscesses occurring in connection with hip disease should be opened and drained as in other parts of the body. Cold ones, caused by the softening and liquefaction of caseous deposits, occasionally, under the influence of rest and food, diminish in size, gradually dry up, and disappear; but even when this does happen, healing is frequently imperfect, and later, if from any cause the health fails, the abscess is very likely to fill again. Aspiration and the injection of iodo form emulsion may be tried if they are small, although with some risk of iodoform poisoning; but the rule should be to open them freely, wash out their contents thoroughly, drain them, and if possible remove the source from which they spring. Counter-irritation, painting with iodine, for example, may be of some little use in the early days of the disease, and may relieve pain and tension in the deep parts, but it can have no influence on caseation, unless, perhaps, it hastens its liquefaction. Many of these abscesses are peculiarly tortuous, making their way under the muscles and sheets of fascia; and not unfrequently they communicate by narrow channels with very much larger collections, which, owing to their depth, are not apparent, so that great care is required to prevent the openings becoming vesicular. In any case, as they are dependent upon diseased bone (except in the rare instances in which they are peri-articular from the first), they are sure to contract into sinuses which, until the cause comes away of itself—or, better, is removed—will continue to discharge a certain amount of serum mixed with flakes of caseous debris.

Later in the course of the disease, years perhaps after apparent recovery, residual abscesses are not uncommon. Apparently the cicatricial tissue around the joint is very poorly nourished and is liable to break down if it is injured in any way, or even from over-exertion. In some instances these abscesses are acute and of very large size; but, as a rule, if they are opened at once, they heal up within a very short time.

(*c*) In the final stage, when the limb is shortened and wasted, more or less ankylosed, and there are open sinuses here and there round the joint, leading down to bare and carious bone, an attempt must be made to improve the position by extension (tenotomy may be occasionally required, but forcibly breaking down adhesions should be avoided as far as possible), and to reduce the amount of discharge by scraping out the sinuses and removing the softened necrosed portions of bone. In many of these cases the true tubercular process has either come to an end altogether or is merely local, causing the discharge of a little caseous pus now and then from some cavity in the bone; and the inflammation is simply kept up by septic conditions or by sequestra not yet separated.

The object is to save the patient from the dangers of hectic and amyloid degeneration. When the head of the femur is lying detached and loose in the cavity of an abscess, or the upper end of the bone is softened and carious, or portions of the acetabulum have undergone necrosis, a more formal operation is necessary, and a kind of excision (differing entirely from that which is done in the earlier days of the disease) may be performed, the sinuses being laid open and the whole of the diseased bone being as far as possible removed. [Excision of the head of the femur should be performed by Koenig's operation, which consists in temporarily detaching the outer and inner borders of the trochanter major from the shaft by the chisel, then cutting through the central portion, and then the neck of the femur; or, the whole trochanter may be separated from the shaft, and restored after the diseased mass is removed.] The same thing may be required in the case of intra-pelvic suppuration, to provide free exit through the acetabulum and prevent the pus extending indefinitely among the tissues and perhaps discharging itself eventually into the rectum or the ischio-rectal fossa.

[There can no longer be question concerning the great value of the injection of iodoform emulsion in cases of tubercular affections of the joints. The dangerous toxic effects of iodoform are not noticed when the iodoform is suspended in glycerine or olive oil. (Senn.) In many injections practiced by myself at the Presbyterian Hospital, I have not met with a single instance of iodoform poisoning. I saw one case at the Marine Hospital, where the drug was used in ethereal solution.]

Finally, amputation may be advisable, either because excision has been performed and the limb is useless, or to save the patient from sinking from hectic or amyloid disease. If the pelvis is involved to any extent the prospect is very unfavorable; but even then sometimes the health improves; the discharge diminishes in amount and escapes more freely, loose fragments of bone come away from time to time, very often with the formation of residual abscesses, and at length only one or two sinuses are left, discharging a small quantity of lymph mixed with flakes of caseous debris.

A slight degree of amyloid disease does not preclude either excision or amputation; in many cases it has been noticed that as the wound diminished in size and the discharge grew less, the waxy color gradually disappeared, the liver became small again, and albumin ceased to appear in the urine.

Osseous ankylosis in a faulty position may be treated either by division of the neck of the femur, or, as the condition of the upper end of the bone is more than doubtful, and it is not impossible that the hyperæmia following the operation might cause all the mischief to return, preferably by section through the bone, in the neighborhood of the lesser trochanter. It may be accomplished either with a chisel or with a saw. Sayre recommends the excision of a portion of the bone so as to secure the formation of a false joint; but unless so much is removed as to make union altogether doubtful, it is almost sure to be osseous.

## SACRO-ILIAC DISEASE.

Tubercular disease of the sacro-iliac joint is very rare in childhood, but is not uncommon in young adult life. Nearly always it can be traced back to some injury; there is an extravasation of blood, generally in the cancellous tissue of the bones, but perhaps sometimes between the cartilaginous surfaces, which, though they lie in contact with each other, are not fused together; the vitality of the tissues is lowered, and tubercle-bacilli gain access to the part, and the characteristic granulation tissue begins to develop.

The subsequent changes are identical with those that occur in other articulations: the cartilage and the bony trabeculæ are absorbed; the neighboring ligaments are softened, so that the joint loses its sense of stability; the amount of gran-

ulation tissue increases until its nutrition begins to fail, and then caseation a liquefaction follow, forming cold abscesses filled with a mixture of caseous deb leucocytes, serum, and shreds of connective tissue. Sometimes these make th way out directly backward, and point over the joint itself; occasionally th spread upward to the lumbar region; more frequently they extend forward, a either follow the psoas or pass out of the pelvis through the sacro-sciatic foram or into the ischio-rectal fossa, or even into the rectum. If left to themselves th break, there is a profuse discharge for a time, and then, sooner or later, unl steps are taken to prevent it, pyogenic organisms as well find their way in.

**Symptoms.**—At its commencement, disease of the sacro-iliac joint is ev more insidious than that of the hip. There is a sense of fatigue or of fugitive pa of an evening or after exertion. The limb feels weak, standing on that leg avoided, the weight, even in sitting, is thrown as much as possible on the oppos side of the body, the patient begins to limp, the gait becomes altered, the step i walking is shortened, and the least extra strain, such as lifting a heavy weight, ev coughing, sneezing, or straining at stool, is checked at once by the pain. Th locality in which this is felt is very variable; most frequently it follows the cour of the obturator nerve, and is referred to the hip or knee, but it may follow th of the sciatic, or be referred to the back, or the gluteal region, or even to the ano In many cases it is very severe, especially when any weight or pressure is allowe to fall upon the joint.

The limb is flexed at the hip and abducted: apparent lengthening is usuall present. There is tenderness on pressure over the posterior surface of the joint frequently the temperature is slightly raised, and the skin appears puffy. Th glutei waste to a certain extent from disuse, and make this more prominen Pressure upon the iliac spines is often exceedingly painful.

Abscesses that advance posteriorly can naturally be detected at once; tho on the anterior surface of the joint may sometimes be felt through the rectum, ( in young and thin adults a certain amount of deep resistance can be made o by pressure on the abdomen, but as a rule they are not detected until they a beginning to approach the surface.

**Diagnosis.**—Inflammation of the sacro-iliac synchondrosis may occur gonorrhœal rheumatism, pyæmia, and in arthritis deformans; the two former, ho ever, are never insidious or chronic in their course, but commence rapidly wi acute symptoms, while the latter only occurs at a much more advanced period life, and has no tendency to run on to caseation or suppuration.

In its early stage it is very liable to be mistaken for tubercular arthritis the hip, especially that variety which commences in the acetabulum. The po tion of the limb may be the same; the pain may be felt at the hip or knee; lim ing and apparent lengthening are present in both, and unless great care be take movements at the hip joint are restricted and painful, because they are commu cated to a slight extent to the sacro-iliac one above. Tenderness on pressure a puffiness over the sacro-iliac articulation are, however, never present in disease; nor does pressure upon the iliac spines, squeezing them together or ap ever cause pain. It must not be forgotten that the two may occur in the sa subject, either independently or from the disease having extended along the pe from one to the other.

Necrosis of the pelvis or sacrum may occur and give rise to symptoms sor what similar; sciatica may be mistaken for it, though the converse is much m likely to happen; spinal disease may give rise to a certain amount of difficult and occasionally symptoms closely resembling it are present in hysteria.

**Prognosis.**—The prognosis is always unfavorable, but so long as caseati does not occur it is by no means hopeless. A large amount of bone may be moved by fungating caries and cicatrization follow, leaving even a certain deg of deformity, without of necessity suppuration ever taking place. If, howev caseation and liquefaction do make their appearance, the prospect of recovery

much more doubtful. It means that the balance of power lies on the side of the bacilli; that the resistance the tissues can offer to their encroachment is very feeble; and that in all probability the progress of the case will be simply from bad to worse, until at length hectic and exhaustion set in. In only one case (Hilton's) is recovery known to have taken place without operation after suppuration had occurred.

**Treatment.**—Absolute and prolonged rest is even more essential in this than in disease of the hip. The loins, the pelvis, and the lower limbs must be rendered perfectly immovable by means of a large, well-padded girdle of leather or plaster, carried down as low as the knee, and the patient must be strictly confined to the recumbent position without being allowed to move on any consideration. For the disease itself in this stage very little can be done; tonics, good food, cod-liver oil, and everything that can improve the nutrition of the tissues must be given freely; and, if possible, the patient should have sea air. The only local application of any service is the actual cautery, which does diminish to some extent the deep-seated hyperæmia and tension.

If caseation and liquefaction set in and the patient is otherwise healthy, the cavity should be thoroughly cleared out, washed with iodoform emulsion, and drained, so that no fluid may remain behind to decompose. If the bones are involved the carious portion must be freely gouged out and treated in the same way. This, however, had better not be attempted if there is any evidence of phthisis, or of tubercular mischief elsewhere. Recovery, with cicatrization of the cavity left, is still possible after suppuration, so long as the affection remains local, although the probability is very much less. [Tubular drainage after Sayre's method, in selected cases may be used to advantage. This consists essentially in chiseling an opening through the bone at the seat of the disease, then by means of an incision over the crest passing an oakum rope or tube drain through the incision and out through the opening in the bone; through this the cavity may be well cleansed and proper disinfection practiced.]

## Tubercular Disease of the Knee Joint.

Tubercular inflammation of the knee may commence either in the synovial membrane or the bone. In the former case (Fig. 271) the whole of the synovial lining and the loose soft tissue around are converted into a mass of gelatinous granulations, in which typical miliary tubercles may be found here and there, and sometimes tubercle bacilli. It may be an inch and a half in thickness; the cavity may be almost obliterated; the cartilages eaten away around their margin; the ligaments softened, the fibres of the capsule separated from each other, and the vascular periarticular tissues everywhere infiltrated to such an extent that the outline of the joint is perfectly uniform and the skin tense and white (*tumor albus*).

In the latter, when the tubercular deposit occurs primarily in the bone (Fig. 270), the changes are to some extent the same, but they differ materially in detail. As in the hip, the neighborhood of the epiphysis (particularly the articular surface of the shaft) is the part attacked; sometimes it is the femur, sometimes the tibia (Fig. 251). A wedge-shaped sequestrum is occasionally present; in other instances there is merely a mass of gray granulations in the cancellous tissue, slowly enlarging at the periphery and caseating in the centre. Whichever it is, the periosteal surface is quickly covered with a layer of new bone, so that escape is barred in that direction. If the inflammation is acute, and the epiphysis is involved—if, that is to say, tubercular embolism on a large scale has taken place—the articular cartilage perishes with the bone on which it rests, and the interior of the joint is gained at once: when, on the other hand, the attack is more chronic, the granulations slowly approach the articular lamella; the joint becomes more or less filled with fluid; and the cartilage is absorbed from beneath or detached in

flakes and thrown off into the interior. In many instances the tubercular infiltration spreads from the epiphysial line directly to the capsule of the joint.

Resolution and cicatrization occur in this as in other forms of tubercular inflammation, and, except in the very worst cases, some trace of repair is always to be found. Caseation may begin in the thickness of the synovial membrane, or in the substance of the bone; but in many instances even when there is very considerable deformity, it never appears at all; or, if it does, the products are absorbed and removed without leaving any evidence of their presence. The granulation-tissue filling up the cancellous spaces of the bone, replacing the cartilages and occupying the synovial cavity and the interstices around it, gradually becomes organized; the joint cavity is obliterated; and the ends of the bones are tied rigidly together.

FIG. 270.—Chronic Osteitis of Inner Tuberosity of Tibia with Consecutive Arthritis.

On the other hand, the caseous foci may enlarge, become more and more liquid, and ultimately form cold abscesses which spread slowly in the direction of least resistance, preceded always by the tubercular deposit. Even then, if they lie in the thickness of synovial membrane or in the substance of the bone, and burst externally, repair may take place, with a certain amount of stiffness. The whole of the infecting material is discharged, or, if any is left, the tissues are able to deal with it, and organization gains the upper hand. But where, as in some instances, caseation is almost general, so that the ends of the bones are completely bared, and the whole of the cartilage detached; or where true suppuration sets in and involves the joint cavity, the destruction is so great that only bony ankylosis is possible.

**Symptoms.**—Tubercular inflammation of the knee joint is essentially a disease of childhood or of young adult life. The synovial form is almost as frequent as the osteal; but, in the early stages at least, one can usually be distinguished from the other.

Pain, heat, swelling, and impairment of function are never wanting, although they vary considerably in different cases. There is no redness of skin until suppuration sets in and approaches the surface. On the contrary, owing to the way in which it is stretched by the chronic effusion beneath, it is often so peculiarly white that this form of inflammation used to be distinguished from all others by the name of white swelling or *tumor albus*. Later, characteristic displacement makes its appearance; the joint becomes stiffened and rigid; abscesses form; grating and starting pains follow; and, in short, all the symptoms of destructive arthritis are developed.

The *aspect* differs according to the seat of the disease. When all the soft tissue around and between the ends of the bones is equally infiltrated, the outline is perfectly uniform; no depressions or elevations are to be seen anywhere. The hollows on either side of the ligamentum patellæ are filled up the first; and by degrees all the rest share the same fate, until the skin is stretched evenly over the whole. When, on the other hand, the bone is attacked the first, or even

chiefly, the swelling is limited, or at least is most marked on one side; it extends much further up and down the bone, owing to the thickening of the periosteum, and is not restricted by the limits of the synovial membrane. There may be some fluid in the joint, or some thickening of the synovial and peri-synovial tissues, but it is not sufficient to obscure the enlargement of the bone and make the swelling uniform.

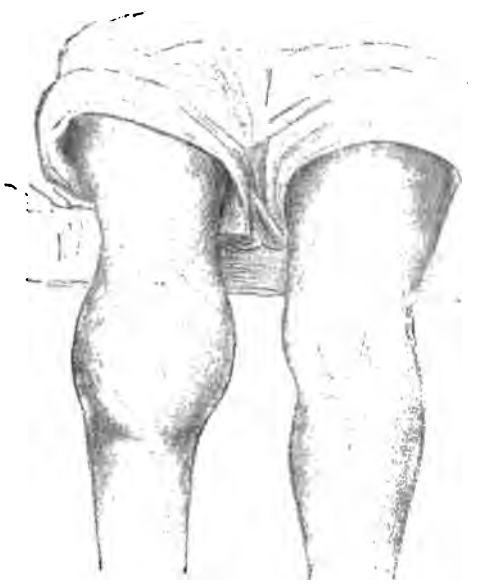


FIG. 271.—Primary Tubercular Synovitis.

*The degree and the locality of the pain*, as might be expected, show a certain difference. In primary tubercular synovitis the disease is often far advanced before the child complains at all, and even then it is only an ill defined aching, worse after exertion; in the osteal form, on the other hand, it is one of the earliest symptoms, and is especially severe at night.

The same may be said with regard to *local tenderness*. In primary synovitis the joint (so long as it is not extended or flexed too far) may be handled freely. When the tubercular centre is in the bone the swelling is usually exceedingly tender, sometimes all over, but in many cases especially at one small spot, the skin over which is puffy and œdematous. In the same way starting pains at night commence at an earlier period in the osteal form and are more severe.

The other symptoms are common to the two and are equally marked in both.

*Movement* is always limited. Complete extension of a knee joint that is in the least degree inflamed is impossible; and conversely a knee that can be extended thoroughly is not inflamed. This does not depend upon the amount of fluid present, although it is true that the capacity of the synovial cavity is greatest when the joint is flexed about 15°, but on the fact that in extension all the fibrous structures around and in the joint, except those on the anterior surface, are put upon the stretch. Complete flexion is equally limited, but this is more difficult to prove.

*The temperature* of the joint is always raised. Great care is required in establishing this: the knees must have been exposed an equal length of time; the suspected one must not have been manipulated; and the same points on each must be compared; but, if this is done, the result may be absolutely relied upon.

*Muscular wasting*, especially of the quadriceps, makes its appearance at a very early period; it may be distinctly marked by the end of two or three weeks.

*Displacement of the tibia* again occurs unusually soon. The joint is kept in the flexed position, so as to relax the muscles and ligaments as far as possible: the two bones simply rest upon each other; the ligaments are softened by the inflammation, and in the position of semi-flexion are nearly all relaxed; the hamstrings are in a state of spasmodic contraction, and from their position act with peculiar advantage; the weight of the limb, and, if the patient is in bed, the pressure of the clothes upon the inner side of the foot, help; and as a result the tibia is displaced bodily backward upon the femur, and is at the same time rotated outward. In the treatment of chronic disease of the knee, the prevention

of this displacement is of special importance; if it is allowed to take place, and the ligaments become firm again, as they do as soon as the inflammation has subsided, it is almost impossible to bring the tibia forward upon the femur. The flexion may be cured and the two made parallel; but the femur is and remains in front of the tibia, so that merely the posterior margin of the condyles rests upon the upper surface of the tuberosities.

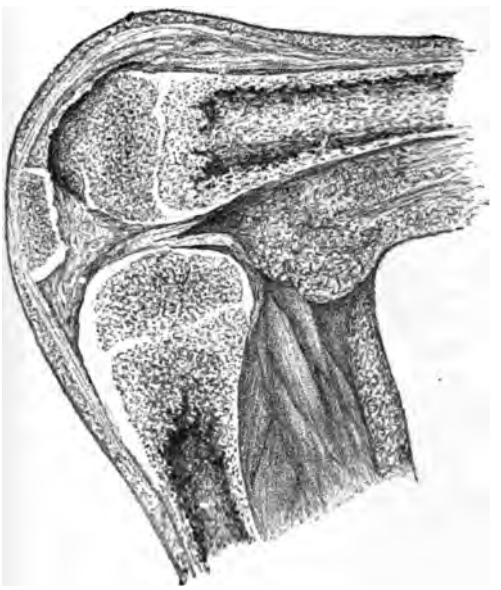


FIG. 272.—Section Through a Knee-Joint, from a case of advanced tubercular disease. The bones are atrophied, the cartilages gone both from femur and patella, and the tibia hopelessly displaced backward.

As the inflammation advances these symptoms steadily become worse. The joint, if left to itself, is flexed until the calf is in contact with the ham and the tibia is almost pulled off the femur; the pain grows more severe; the swelling increases in size; abscesses make their appearance and burst externally, leaving sinuses lined with pale, flabby granulations; starting pains come on, showing that the articular cartilages are in part destroyed; the least attempt at movement, even touching the bed, causes intense suffering; and, finally, suppurative arthritis is added to the rest.

The constitutional symptoms at first are but slightly marked; as the disease advances a certain amount of fever makes its appearance, especially of an evening; the health begins to fail, partly from this, partly from the pain and the want of exercise; and the patient loses flesh and strength. Later, when suppuration occurs, this is much more marked; the temperature becomes characteristic of hectic; the emaciation is extreme; the appetite is completely lost; the face is flushed; there are profuse night-sweats, and in some cases the strength fails to such an extent that it is difficult to believe that the disease of the knee, bad though it may be, is the only trouble from which the patient is suffering.

**Diagnosis.**—The age of the patient, the peculiarly insidious character of the disease, the difficulty of assigning even an approximate date for its commencement, and the soft, doughy, semi-elastic feeling, are distinctive. In primary tubercular synovitis the outline of the joint alone is sufficient; no other affection causes such a perfectly even, rounded swelling. When the disease begins in the bone the difficulty may be somewhat greater, but chronic osteitis of the articular ends of the bones very rarely occurs in children or young adults, except from tubercle or syphilis.

The history of the case is often exceedingly misleading, the lameness comes on so gradually, that very often it is not noticed by the parents until the disease is far advanced, and they may insist that the child has been perfectly well until a day or two before. Such evidence, however, is worthless in comparison with that afforded by the change in the physical characters of the joint and the wasting of the limb.

The difficulty is greatest in the case of syphilitic synovitis. This is more common in the hereditary than in the acquired variety, and is usually secondary to osetitis or periostitis of the articular ends; when, however, the synovial membrane is involved by itself, it resembles tuber[illegible]mmation very

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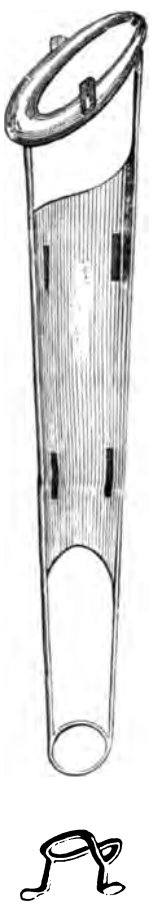
f doubt, or where there is a history of
ı to local measures, to try the effect of
l doses. Occasionally the difficulty is



'IG. 273.—Thomas's Knee-splint with patten.

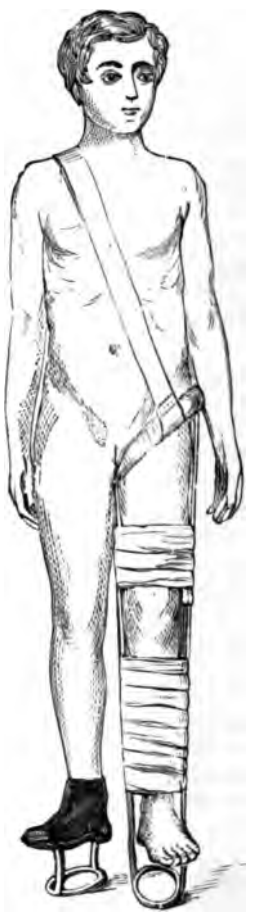


FIG. 274.—Thomas's Knee splint applied.

out. Recovery may be perfect; or
movement, may be left; or the bones
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neral health; the limb must be brought
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ıld not be borne, the thigh must be

raight; if it has already become bent, it

must be slowly and quietly brought nearly into line again, either by means of weight extension or with Thomas's splint. If the former is used, the same precautions must be taken as in the case of the hip joint, to make the extension in a line with the leg and not with the body, so as to avoid causing intra-articular pressure. This may be accomplished by placing the leg upon a well-padded horizontal support at a suitable height above the bed, and adjusting a weight by means of a stirrup.

Thomas's knee-splint is no less valuable than that devised for the hip. It consists of an upper ring fitting accurately round the thigh as high up as possible, and of a strength proportionate to the weight of the patient; and of two upright iron rods, coming down one on each side of the leg and terminating below in a patten. These should be so long that no part of the foot can in any way touch the ground when the splint is adjusted. The upper ring, which is thickly padded on its inner side and behind where the tuberosity of the ischium rests upon it, is placed at an angle of 45° with the inner of the two uprights. In front, where it lies just below Poupart's ligament, it is nearly straight, to correspond with the flattened surface of the front of the thigh; behind it is fuller; and at the outer end, which lies under the anterior superior spine, it is more sharply bent than at the inner. The outer upright is attached exactly at the mid-lateral line; the inner one should be a little in front of it. This ring is supported in position by a broad strap passing from front to back over the sound shoulder.

Between the two uprights there is a broad apron of leather extending from above the middle of the thigh to below that of the leg, so that the limb rests on it, between the bars. Near its upper end there are two slits, one on each side, for the bandages that are used to fix the thigh. This part of the limb must be as firm as possible. Two bandages are employed, one for each bar; and each passes round the limb and one bar first, and then outside everything, round splint and limb. The object is to fix it so that, when the patient is lying down, the patten below the foot can be raised or lowered, moving from the hip joint, without the knee experiencing the least sensation. The leg, which need not be fastened so firmly, is secured by a stirrup attached to a bar at the bottom of the splint (but not with the view of causing extension) as well as with side bandages. If the knee is much bent, the apron cannot be used; the patient must be kept in bed with the patten supported and raised, so that the weight of the limb gradually straightens out the joint. Afterward, when the position is better and the acute symptoms have subsided, a patten is placed under the opposite foot to equalize the two limbs, and the patient is allowed up, on crutches, resting a little of his weight on the tuberosity of the ischium.

In the case of younger children, or where the pressure of the ring on the inner side of the thigh causes inconvenience, the limb must be secured by leather splints or by plaster-of-Paris, gum and chalk, or some other of the appliances described under the head of fractures, but they do not secure such absolute rigidity.

In the vast majority of cases, if the child can only be tided over a period of one or two years, a fairly good result may be obtained by this. Splints may have to be worn for a very long time; the range of movement may be limited, and the muscles may waste considerably, but the growth of the part is not affected, and by degrees the risk of general tuberculosis and of relapses becomes less and less.

In the synovial form elastic compression, by means of many layers of absorbent wool, may be tried with advantage; it helps to reduce the hyperæmia, promotes absorption, and keeps the part in the most perfect rest. When the disease commences in the bones, especially when there is a tendency to starting pains at night, progress may be checked, for a time at least, by means of the actual cautery, applied at a black heat, while the patient is under an anæsthetic.

If caseation and liquefaction occur in the synovial membrane, the cavity should be tapped and injected with iodoform emulsion [with antiseptic precautions], in the hope that, if this mass of caseous material is dealt with thoroughly,

he disease will cease to spread, and that under proper treatment organization and icatrization will progress until the age is reached when the tendency is for the tuber- ular process to come to an end. In the osteal form, when a tender and swollen pot can be definitely distinguished on one side of the joint, unless the symptoms peedily and thoroughly disappear, there should be no hesitation in making an xploratory incision; and if the periosteum is thickened or separated from the ompact layer of the shaft by inflammatory effusion or a deposit of new bone, it hould be carried into the substance of the bone beneath. It is no uncommon hing, when performing excision for old disease of the knee joint, ankylosed in a faulty position, to find a cavity sometimes containing a sequestrum in one or other of the bones, communicating with the interior by means of a long, narrow sinus.

If the thickening of the synovial membrane continues to increase in spite of treatment, arthrectomy may be performed, but it is an operation that requires the greatest care. Every particle of soft gelatinous tissue must be removed, and primary union must be ensured; if suppuration follows, the limb has nearly always to be amputated. A movable joint can usually be obtained, but splints are required for many years, to prevent flexion.

Excision may be reserved for those cases in which the articular ends of the bones are too much involved, or in which, after the disease has subsided, the limb is practically useless, owing to the amount of flexion or of displacement of the tibia.

### Tubercular Disease of the Ankle Joint.

Tubercular inflammation of the ankle joint usually begins in the synovial membrane, but it may extend from the lower end of the tibia, or more rarely from the fibula or the astragalus. The general symptoms and treatment are identical with those given already, but there are certain points that require a little further detail.

The diagnois is often a matter of great difficulty. The astragalo-scaphoid and astragalo-calcanean articulations are exceedingly close, and if they are diseased the symptoms are almost the same. Pain, heat, swelling, and limping, caused by mpaired mobility of the part, are always present, and the greatest care may be ecessary to separate disease of one joint from that of the other.

The swelling is most characteristic when seen from behind; it takes the form f a soft, puffy fullness, lifting up the extensor tendons in front, and occupying e hollows on either side of the tendo-Achillis. Special attention should always e paid to this. Movement may appear to be free, but the foot can never be flexed extended so far as the opposite one. Heat, muscular wasting, pain, and ten- rness on pressure vary very greatly in different cases.

The diagnosis must be made from disease of the neighboring bones, tubercular filtration of other joints, and effusion into the sheaths of the tendons round the int. In many cases, even when sinuses are present, it is almost impossible to ake certain without exploration.

The treatment consists in perfect rest, combined with elastic compression, ntil all the tenderness and rigidity have subsided. The foot must be kept accu- tely at a right angle the whole time, or otherwise, if the joint does recover with certain degree of stiffness, an operation may be required afterward to correct it. aseation may be treated [first by injection of iodoform emulsion, and after- rd] by free incision and erasion with a sharp spoon, but arthrectomy or removal the whole synovial surface is not so successful as it is in the knee. When the nes are involved an attempt must be made to open and drain the caseating cus; or if this is too extensive, and the disease is limited, excision may be ed, but the operation is not a very successful one and entails a protracted con- lescence. Excision of the os calcis or astragalus sometimes succeeds; and if e anterior part of the foot is perfectly sound, osteoplastic resection after the

method of Mikulicz is strongly recommended. The heel, with the astragalus, calcis, and the soft parts over them, is removed entirely; the articular surface tibia and fibula above, and of the scaphoid and cuboid below, are sawn off, and the front of the foot is brought vertically under the leg, so that the toes assume the position of extreme equinus. MacCormac has performed this operation on several occasions with a very good result.

Finally, when the other bones of the tarsus are too much diseased, or the patient's health is beginning to suffer, or suppurative arthritis has set in, either Syme's or Tripier's amputation must be performed.

### Tubercular Disease of the Shoulder Joint.

Tubercular inflammation of the joints of the upper extremity (except perhaps the carpus) is more amenable to treatment. The articulations are smaller and more accessible; they have not the same amount of work to do, nor is the work so severe; and the patient can rest them more easily without being confined to bed.

In the shoulder joint the inflammation usually commences in the synovial membrane; sometimes, however, the upper epiphysis of the humerus is almost excavated from the interior by masses of granulation-tissue. Owing to the freedom with which the scapula moves upon the thorax, the joint is kept at rest, and, as pain is rarely severe, the disease may almost run its course and lead to fibrous ankylosis without being noticed. The movements are awkward, especially overhand ones; there is a certain amount of tenderness on pressure, chiefly when the bone is affected; muscular wasting (particularly of the deltoid and supraspinatus) is very distinct; but suppuration is rare, and the gelatinous infiltration is seldom sufficiently extensive to cause much swelling.

Fig. 275.—Sequestrum in Head of Humerus.

The local treatment simply consists in perfect rest; even the fingers should not be used until the active stage is passed. If, from the severity of the pain at night, or from tenderness on pressure, there is a suspicion that the upper epiphysis is involved, the actual cautery may be tried; and if it continues in spite of this, an exploratory incision should be made down and into the bone from the outer side. Necrosis is rare, but occasionally the head is completely eaten away by fungating caries and caseation. If suppuration occurs in connection with the synovial membrane the pus usually makes its way under the deltoid either to the front or the back of the joint. Recovery is the rule, but even in the slightest cases a very considerable degree of stiffness is often left; fortunately the use of the limb is but little impaired, and it is rarely advisable to break down adhesions. Erasion and excision are seldom called for [but here, as elsewhere, the iodoform emulsion properly injected often arrests the progress of the disease].

### Tubercular Disease of the Elbow Joint.

This is very common in children, and is usually assigned to accident; as a rule it begins in the synovial membrane; the epiphyses are not so frequently involved as in other bones.

The early symptoms are obscure and ill-defined. There is a little fullness on either side of the tendon of the triceps, the muscles of the upper arm are wasted, complete extension cannot be carried out, though the other movements may appear fairly free, and the joint is held rigidly flexed at an angle of about 135°. After a little time the fullness makes its appearance over the head of the radius on the outer

ide of the joint as well; the swelling becomes more distinct; rotation at the houlder joint replaces pronation and supination; the temperature of the skin is listinctly raised, and the diagnosis is beyond dispute.

As time passes the swelling of the case is neglected, grows larger and larger ntil the joint is completely involved in a spindle-shaped mass the size of which s exaggerated by the wasting of the muscles; caseation sets in and is followed y liquefaction; the skin becomes thin and undermined; and at length the abcesses break externally, leaving sinuses filled with a mass of soft, pulpy granulation tissue. Finally suppuration occurs and the pus makes its way into the synovial cavity, destroying utterly the cartilages and bones, which are already in great measure eroded and replaced by the tubercular deposit.

If the treatment is commenced at once, recovery may be looked forward to with a fair range of movement. The joint must be enveloped in cotton-wool and fixed with plaster-of-Paris or gum and chalk, so that not the slightest movement is possible. Scott's dressing may be applied underneath for a week or two, but care must be taken, especially in children, that it does not irritate the skin too much. If this is kept up for some months, the splints being changed as often as necessary, the inflammatory exudation disappears, and though the muscles waste considerably the joint is rarely much stiffened or seriously reduced in strength.

When the case is not seen until the disease is further advanced the same treatment should be tried, but the hope of success is not nearly so good; at the best a large amount of the exudation must become organized, leaving the joint more or less rigid; and for this reason it is essential to maintain the flexed position. When abscesses make their appearance they must be opened and drained, or f they are limited in size nd the tissues round them re fairly firm, they may e thoroughly scraped out id filled with iodoform. nally, excision may be rformed, either with the ew of removing the whole tubercular mass, and therefore during the course of e disease, or afterward, for ankylosis in a faulty position, especially as the results this operation are exceedingly good even in the case of children.

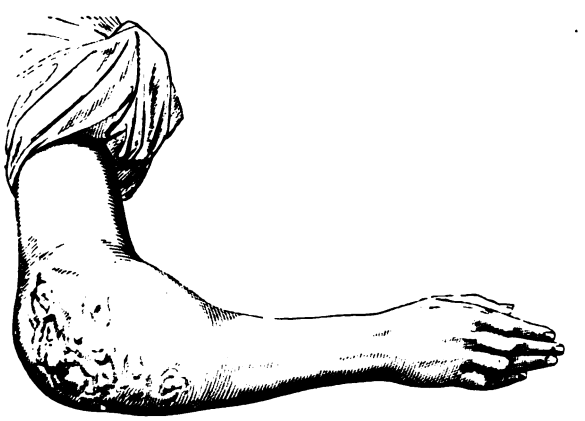

FIG. 276.—Disease of Elbow Joint.

## TUBERCULAR DISEASE OF THE WRIST JOINT.

Disease of the wrist may begin either in the bones or the synovial membrane, obably in the former the more frequently of the two; but, whichever it is, it y soon extends until the whole of the articulation is involved. Certainly the jority of cases that I have seen have occurred after puberty, and many of them e in life.

The symptoms, as in tubercular arthritis generally, are peculiarly insidious. nitation of movement is hard to detect, but it is usually present; wasting of the scles of the forearm is one of the earliest signs, and a characteristic ill-defined elling, which runs transversely over the dorsum of the wrist, obliterating the tinctness of the different tendons. At the same time there is a sense of weakss, the hand is rested whenever there is a chance, the joint is unconsciously ted and slightly adducted, and the temperature of the part is distinctly raised,

but pain is seldom present. If the case is left to itself the ordinary consequences —caseation, liquefaction, and suppuration—make their appearance sooner or later.

Like the same disease when it affects other joints, tubercular arthritis of the wrist in its early stages is very amenable to treatment, provided it is carried out thoroughly, locally and constitutionally. The joint must be [injected with iodoform emulsion and] kept upon a splint, with even, equable pressure all round, and not even a finger allowed to move for months, until the heat and swelling have entirely subsided; and even then it must be well guarded for fear of relapse. In the later ones, when caseation and caries have occurred, more good may be done in the same way, laying open and scraping out sinuses and removing carious portions of bone from time to time, than by any formal excision.

## LOOSE BODIES IN JOINTS.

Loose bodies of various kinds are occasionally met with in the interior of joints, giving rise to peculiar and very characteristic symptoms.

Some of them are like the melon-seed bodies found in bursæ and ganglions, mere concretions of fibrin which swell up on the addition of acetic acid, so as to become almost translucent, and show no other sign of structure than a faint concentric marking round a granular nucleus.

Whether blood effused into the cavity of the joint can give rise to loose bodies is somewhat doubtful; but there is no question that, sometimes at least, they originate as extravasations in synovial villi, which later become pedunculated and fall off into the synovial cavity.

By far the majority of these growths begin in the villi which are so common round the margins of the articular cartilages, where the synovial membrane is reflected upon itself, and are the result either of injury or of slight degrees of osteo-arthritis. This may account for the fact that they occur so frequently in young adults, and in the knee, which surpasses all other joints of the body to such an extent in the size of its synovial membrane and the range, variety, and immense leverage of its movements. The little projection, once formed, continues to enlarge; cartilage corpuscles, which are so often met with in this situation that they must almost be regarded as normal, make their appearance in the end; and at length it assumes the form of a more or less rounded body, suspended by a narrow neck of fibrous tissue which may easily be torn across on any sudden movement. True bone is not unfrequently developed in the interior of the larger ones, the cartilage-corpuscles immediately round the osseous nucleus being ranged in vertical columns, and those near the surface flattened out, just as they are in the normal hyaline cartilage at the end of a bone. One of the most common situations is in the inter-condyloid notch of the femur; and then, unless it is dislodged, in process of time the abnormal growth wears out a bed for itself, so that it acquires the appearance of a portion of the articular surface broken away from the rest. As the cartilage is not unfrequently worn away from one side of it, leaving the bone exposed, the resemblance is exceedingly close. Humphry, however, has shown that, although this may possibly have happened in one or two instances as the result of a violent wrench, there is no proof of its ever having followed a blow. Even those that contain bone are nearly always developed from villi; they lie latent for years, slowly increasing in size and becoming more complex in structure; then suddenly they are dislodged from the cavity they have worn for themselves, and it is imagined they are just broken off. Their structure is not identical with that of the articular border. A certain amount of fibro-cartilage can always be found as well as true cartilage, and usually there is some trace of it on that surface which has apparently been separated from the bone by fracture. The osseous nucleus is irregular in outline, the bone development imperfect, and the size often greater than that of the cavity from which it seems to have been broken out, so that when fitted in it rises above the surrounding level.

In exceptional cases loose bodies are derived from other sources. Osteophytes, example, are sometimes accidentally detached from the margin of a bone ted with osteo-arthritis. Portions of the semilunar cartilages are torn off. one instance the nucleus was found to be the point of a needle. In another e was a pedunculated sarcoma. Fatty outgrowths, almost detached, are not mmon, and Paget, Teale, and others have described a process of quiet necro- in which pieces of the articular cartilage, with or without a portion of the lying bone, exfoliate after injury, and drop into the joint, without causing of the symptoms usual under such circumstances.

As a rule foreign bodies are single, especially when they occur after injury; cases of osteo-arthritis there may be any number. For the most part the size is all, but they have been met with as large as the patella and even larger.

**Symptoms.**—A certain degree of uneasiness and weakness, caused by the reased synovial effusion, is usually present when there is a foreign body, whether is loose in the anterior of the joint or floating at the end of a pedicle; but the st striking effect is produced when it is caught between the bones. The patient, ile in the act of walking, is suddenly seized with the most intense pain; all wer of the limb is lost and he drops to the ground, very often sick or fainting: has slipped between the articular ends, and, as the limb is straightened it acts a wedge, forcing them apart, straining all the ligaments, and crushing the rtilages. If it is fairly caught and held, the joint is locked and cannot be used pain until the body slips out or is dislodged by manipulation; if, as it usually es, it just escapes, the patient is able to move the limb after the pain has sub- ded: but in either case the synovial cavity rapidly becomes filled with fluid, and attack of acute synovitis, similar to that following any kind of sprain, sets in.

Generally speaking, the patient soon becomes aware of the presence of a se body, and very often is able to find it by a little manipulation. The most mmon situation in the case of the knee is on the outer side of the joint, just ve the condyle; sometimes they can be felt at once, at other times only with e greatest difficulty and after repeated examination, and they slip aside again as on as they are found. If they are left, they may remain latent for months thout causing a fresh attack; or they may be caught every day, and even several mes a day. After a time the repeated attacks of synovitis lead to degeneration the synovial membrane; it becomes thickened and covered over with fringes; mmon synovitis sets in, and the attacks are felt with less severity, but the condi- n of the joint is practically irremediable.

Hypertrophied fringes in osteo-arthritis, pedunculated masses of fat project- g from the ligamenta alaria or mucosum, and displaced or elongated semilunar rtilages give rise to symptoms of the same character but less intensity. In the st, however, the synovial membrane of the joint becomes disorganized in the me way: movement becomes restricted and painful; and walking is almost im- ssible from the feeling of insecurity.

**Treatment.**—If the joint is locked the loose body must be dislodged by ap- propriate manipulation, and the effusion that follows checked by cold and pressure. ce as the inflammation has subsided an attempt must be made to find the body (in which the assistance of the patient is usually necessary) and fix it in some out- ing or superficial part of the joint. A very convenient way of doing this is to ssure the joint in a sheet of chamois leather spread with lead plaster, placed und the limb, and then carefully brought up on each side of it. If this can be ne the patient is safe for the time.

Except, perhaps, in the case of advanced osteo-arthritis, or when the synovial embrane is covered all over with masses of vill, there is no doubt loose foreign dies should be removed as soon as possible; and the same may be said of many nerculated ones when they can be isolated, as by their presence they merely se to induce the same changes in the rest of the synovial lining, until at length s condition becomes hopeless. The operation, if due precaution is taken to ure absolute cleanliness, is exceedingly successful.

The limb should be placed upon a splint for at least forty-eight hours before in order that the patient may become accustomed to it; the confinement alone is sufficient in many cases to cause a certain degree of feverishness. The skin, instruments, hands, etc., should be thoroughly cleansed with an antiseptic; the foreign body fixed, either between the finger and thumb, or by driving through it a straight needle and pinning it down to the bone (I have known it escape even then) and an incision made down on to it so that it may be squeezed out without manipulation. A catgut suture should be used to unite the synovial membrane; all hemorrhage stopped; the edges of the wound brought accurately together; some iodoform dusted over the incision, and the limb replaced upon the splint and thoroughly packed all round so that there can be no hyperæmia or exudation. This should be left for a week; at the end of that time the wound is healed; the splint may be left off and the patient allowed to move the limb in bed, although the joint usually requires support for some time longer. When there are a number of loose bodies this is impracticable and the joint must be laid freely open and washed out. If any one of them is pedunculated, the incision should be made over it as nearly as possible, so as to get at the pedicle and divide it.

Formerly an indirect method was occasionally employed. The synovial capsule of the joint was divided subcutaneously with a long tenotomy knife, and an attempt made to force the cartilage through the opening into the subcutaneous cellular tissue, in which it would be left, either permanently or until the wound in the joint had healed. The operation, however, is very much more difficult to perform, and it has not been shown to possess any advantage in the way of safety.

## ANKYLOSIS.

Ankylosis in the strict sense of the term signifies the angular position of a joint; but this meaning has long since been lost, and now it is used indiscriminately for articulations that have become stiff from organic changes in the structures immediately around them without reservation as to angle. It may be *bony or fibrous*, and the latter may be either *intra* or *extra-articular*, although clinically it is often difficult to distinguish one from the other; but the term is not applicable to cases in which the limitation of movement is due to the contraction of structures not directly connected with the joint (the cicatrices of burns, for example, or the degeneration of distant muscles), or those in which the cause is merely muscular spasm that disappears at once under an anæsthetic.

The distinction between true and false ankylosis should be dropped. The latter is used by some for simple muscular contraction, while, by others, it is restricted to cases in which there are definite organic changes in the tissues outside the capsule.

**Causes.**—Ankylosis is in most cases the product of inflammation; but anything that impairs the nutrition of a joint for any length of time—prolonged confinement, for example, in one position, or section of the nerves going to it—is liable to produce it. Perfect movement naturally cannot take place without perfect nutrition, so that a certain degree of stiffness is intelligible under these conditions; but it is difficult to explain the bony union which has been known to occur.

The degree of rigidity depends to some extent upon the character of the inflammation (chronic rheumatism, for example, has a special tendency toward organization and rigidity), but much more upon the depth to which the tissues of the joint are involved. In sprains the loose and soft cellular tissue outside the capsule, the ligaments and surrounding muscles, usually suffer most, so that the chief obstruction is extra-articular; the interior of the synovial cavity may, it is true, be filled with blood; but, except in those cases in which it becomes organized as a lining membrane, it seldom causes any after-trouble. Chronic rheumatism attacks the fibrous structures chiefly, so that the capsule, ligaments, fasciæ, and tendon sheaths

yielding mass; the cartilages wasted and thinned; the tendons glued to their sheaths; and the skin bound tightly down by the wasting of the cellular tissue beneath, as if it were shrunken on to all the bony prominences. Sometimes all these changes exist together; sometimes there is only a single adhesion inside the joint cavity, the tip of a synovial fringe, for example, tied down by a fibrous band to some distant part of the capsule; and often it is impossible to say what the condition of the joint may be, and how far it is involved, without placing the patient under an anæsthetic and ascertaining the range of movement and the strength of the obstacles that prevent it.

FIG. 277.—Osseous Ankylosis of Elbow Joint.

**Diagnosis.**—Bony ankylosis can usually be diagnosed by the extreme muscular atrophy and the entire absence of pain even when the part is roughly manipulated. If there is the least degree of mobility left, too small to be appreciated by the hand, the muscles round the joint involuntarily start into spasmodic contraction as soon as any force is used; with bony ankylosis they remain absolutely flaccid. The distinction between intra- and extra-articular rigidity turns rather upon the cause than upon any symptom that may be present; it is rarely possible to be certain, but probably the former is seldom met with by itself.

**Treatment.**—*Bony Ankylosis.*—In many cases this is the best result that can be obtained under the circumstances, and provided the position is good, it should not be touched. If, for example, the elbow is flexed to a right angle (or preferably a little less) the hand can be used for all ordinary purposes with perfect freedom; when it is more open, so that the fingers cannot be brought to the mouth, it becomes a question whether excision should not be performed. The hip and knee when nearly straight impair the power of the limb very little, although the gait is awkward; if, however, they are much flexed, excision (removing a wedge-shaped piece) should be performed in the one case, osteotomy (either through the neck or below the trochanter) in the other. In the case of the shoulder, ankle, and fingers, neighboring joints compensate so thoroughly that active treatment is rarely necessary. Bony ankylosis of the temporo-maxillary articulation, on the other hand, naturally cannot be left.

*Fibrous Ankylosis.*—The function of the part may be restored, or at least improved, by stretching the adhesions, or forcibly breaking them down. Nothing, however, may be attempted so long as there is the least degree of inflammation; it would merely cause a fresh attack, the danger that is feared the most.

The probability of inflammation depends chiefly upon the nature of the original cause. If this was traumatic—if, for example, the joint was sprained or dislocated, and the injury repaired at once—the risk is exceedingly small; breaking an adhesion across, once for all, in a healthy person, is not more likely to cause inflammation than breaking a bone. If, on the other hand, it was constitutional, whether due to gout, rheumatism, tubercle, or any other cause, and the same diathesis is present still, there is no question that violent manipulation may be followed by very serious results. Fortunately, even in these cases, the predisposing causes are not always of the same intensity; gout and rheumatism, for example, admit of being alleviated; and, especially in the case of joints and bones, the susceptibility to tubercle is of limited duration; so that, by selecting a proper time, when the general health is good and the skin over the affected joint perfectly

ual, and by adopting suitable precautions before and after, a very great deal may be effected in the vast majority of instances, with the minimum of risk.

The other question, whether the adhesions should be broken down once for all (under an anæsthetic if necessary), or gradually stretched little by little until they give way sufficiently to allow free movement, is more easy. This depends almost entirely upon their extent. If they are small and few in number, or if they are so situated that they can be taken one by one—round the capsule of a joint, for example—and snapped across by successive rapid action, the chance of inflammation following is very much less than if they are strained each day by the application of some continuous force, and recovery is more perfect. It is mainly owing to their skill in localizing lesions of this kind, in the neighborhood of joints, and to the experience they have gained in the necessary manipulation, that bone-setters have acquired so great reputation with many people, in spite of their frequent failures, and in not a few cases disastrous results. Very little, on the other hand, can be done in this way in the case of the short and dense intra-articular adhesions that form after suppuration or advanced tubercular disease. These may be stretched to a certain extent by continued traction so as to alter the position of the limb if that is faulty; but, as a rule, any attempt at restoring mobility by more active measures is only too likely to end in failure.

Tenotomy is rarely required in cases of fibrous ankylosis, except for distant tendons or thickened portions of the fascia that have undergone passive contraction. The punctures should always be allowed to heal soundly before the least manipulation or extension is attempted for fear of the skin giving way.

Whichever plan is adopted, it must always be remembered that tearing, stretching, or cutting the resisting bands is only half the cure. Owing to prolonged rest, all the structures around the joint are wasted, stiffened, and incapable of work, and, after all gross mechanical obstacles have been removed, these must be brought into a thorough state of nutrition before they can be expected to work freely and painlessly. The joint must be well steamed and douched; all the tissues kneaded thoroughly and well rubbed with oil; the muscles manipulated and stretched; and passive and what are known as resistive movements assiduously practiced.

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## SECTION VI.—EXCISION OF JOINTS.

By excision is understood the formally-planned removal of more or less of the articular surfaces of a joint, not merely the synovial membrane (erasion) or the part that is obviously diseased. It may be required either for injury (this is sometimes distinguished as primary excision), disease, or deformity.

(*a*) *In cases of injury*, excision is performed as an alternative to amputation. Except at the hip joint, it is the more serious operation of the two, entailing prolonged confinement, and should not be preferred unless the age and constitution of the patient (particularly the state of the kidneys) are favorable. It is essential that the main blood-vessels and nerves of the part should be intact, and the skin not too much bruised.

(*b*) *For Disease.*—Tubercular arthritis is the most frequent cause, osteoarthritis an exceptional one, and other forms of disease still more rare. For it to succeed, the inflammation must be chronic or past; the age of the patient suitable; the viscera sound (without amyloid degeneration, or, at the very most, a suspicion of it); the bone not too extensively diseased (if the epiphyses are cut away the growth and utility of the limb are so much impaired as to raise the question whether amputation would not have been better); and all the soft parts involved available of free removal.

(*c*) *For Deformity.*—This may be the result of injury, or of antecedent inflammation—septic, tubercular, or rheumatic—or in some rare cases it may be congenital. The question here is an entirely different one, depending upon the

utility of the joint in its deformed position; the probable utility of the part after excision, judging from previous experience; and the possibility of rectifying the deformity more or less completely by some less serious operation, such as subcutaneous osteotomy.

*General Principles.*—The soft parts are incised in such a way as to expose the interior of the joint with the minimum of injury to the structures around. The epiphysial lines must be kept intact. How much bone is taken away (beyond that which is diseased) is regulated by the kind of union that is required, bony or fibrous. The whole of the disease must be removed; if there are outlying sinuses or tubercular foci in the bones, they must be thoroughly scraped out. Perfect drainage must be provided for, and the dressing and splints must be arranged so as to keep the part at rest and exert sufficient pressure upon it, while at the same time they admit of being changed, if required, with the minimum of disturbance. Passive motion, if enough bone has been taken away, need not be commenced until the wound is practically sound; but where, as in the case of the wrist, tendons that move other joints have been exposed and handled, these should be worked after the first day in order to prevent the formation of adhesions.

The preservation of the periosteum is only to be attempted when a great reproduction of bone is advisable. If the bones are soft and inflamed, as in most instances of tubercular arthritis, its separation presents no difficulty, but in primary excisions it adheres so closely that very often it is too much bruised to live.

In cases of fibrous union and when movement is desired, massage, shampooing, and galvanism should be commenced as soon as possible. The muscles and nerves are atrophied from prolonged disuse, the circulation through the limb is very feeble, and it requires much time and patience to bring back the part to its normal state of nutrition.

## EXCISION OF SPECIAL JOINTS.

### 1. The Upper Extremity.

#### *Excision of the Shoulder Joint.*

This may be required for injury or disease. Ankylosis is compensated for so thoroughly by the mobility of the scapula that it is a question whether operation is advisable. It has also been performed for unreduced dislocation in which the head of the bone was resting upon the brachial plexus, and for tumors in connection with the upper extremity of the humerus.

(*a*) *Injury.*—In this case the operation merely consists in removing comminuted, displaced, and detached fragments of bone through the wound (enlarging it if necessary), cleansing the cavity thoroughly, and providing free drainage.

(*b*) *Disease.*—Tubercular osteitis of the head of the humerus, involving the synovial lining secondarily and spreading to the glenoid fossa, is the most frequent cause; but, even in this, expectant treatment, removing carious or necrosed fragments of bone and scraping out old sinuses, is usually followed by such a good result that excision is seldom practiced. For other forms of inflammation—osteo-arthritis, urethral arthritis, acute necrosis, or chronic suppuration—it is still more rare.

The usual incision is vertical, between three and four inches in length, beginning just outside the coracoid process, on a level with it, and carried through the skin, fascia, and deltoid, down to the bone. If the arm is rotated outward and the soft part drawn to the sides, the tendon of the biceps is exposed at the bottom. This should be preserved if possible; sometimes it is in a pulpy condition, or has already been eroded, and occasionally it is fixed firmly to the bone in its groove, and the upper end of it lost. The capsule is then freely opened and the condition of the parts examined before determining how much it is necessary to take away.

So far as the subsequent utility of the limb is concerned, there is no doubt that the more of the bone that is left the better. Partial resections (in which

some of the head is left, the rest being gouged away) give better results than when the anatomical neck is divided; and this is to be preferred to the surgical neck. The whole of the disease must be removed (and in cases of tumors springing from the head of the bone one-third and in some cases even more of the shaft has been excised, preserving the elbow and the hand), but consistently with this, as little as possible of the healthy bone. The question of subperiosteal excision is still open, but there is ground for believing that where it is practicable the results are superior to the other method.

If the surgical neck requires division the arm must be strongly rotated outward by the assistant as soon as the capsule is opened, in order that the tendon of the subscapularis may be cut; and then inward for the short external rotators. As soon as this is done the head of the bone rises well up into the wound, and may be either sawn off with a narrow-bladed saw *in situ*, the soft parts being protected and held aside by retractors, or thrust bodily out. The glenoid fossa very rarely requires more than the application of a gouge.

[Prof. Senn's method of exposing the shoulder joint by temporary resection of the acromion, was performed by the editor at the Rush Medical College Clinic, January, 1893. The operation is not difficult of performance, and the conservation of muscular attachments by this procedure is of extreme value in the result.]

A counter-opening at the back of the joint is usually advisable for drainage. The wound is thoroughly cleansed; the margins drawn together with sutures; a large tube placed across it; and the cavity of the axilla, the space behind the shoulder, and the outer side and front of the arm thoroughly packed with wood-wool. Stromeyer's elbow cushion should be used as long as the patient is in bed, and passive motion commenced as soon as the condition of the wound allows it, the fingers and wrist being exercised from the first.

**Results.**—All underhand movements can be carried out exceedingly well; elevation above the horizontal line is only possible in those cases in which the head of the bone is partially preserved or reproduced; in all others the deltoid loses its fulcrum, and the perfect apposition of the two bones, which enables rotation of the scapula to raise the arm, becomes impossible.

### *Excision of the Elbow Joint.*

*Primary excision* for compound comminuted fracture extending into the joint is very successful. As usual in primary operations, the reaction is greater than in the cases of disease, and, if suppuration occurs, a very large amount of callus may be thrown out, endangering the movement of the joint. It is chiefly required when the lower end of the humerus is comminuted. When this occurs it is practically impossible to restore the fragments to their proper position, and owing to the irregularity of the articular surface and the filling up of the coronoid and olecranon fossæ, a much wider range of movement can be obtained by operation.

*Excision for Disease.*—Tubercular arthritis is the usual cause, but the proportion of cases in which the operation is required is a very small one. Strumous disease of the elbow joint is essentially an affection of childhood, a time in which excision should if possible be avoided, owing to the way in which it interferes with the growth of the arm; and in the vast majority of instances, if the patient's surroundings can be improved, the joint kept at rest upon a splint, abscesses opened from time to time, and sinuses and carious bone scraped out, the result is an exceedingly good one. The range of movement, it is true, may not be so wide; but if proper attention is paid to position it is usually sufficient, and there is no risk of a "flail joint," or of failure of growth. There is certainly the danger of the tuberculosis becoming general, but it rests with the advocates of excision to prove that this is serious. Of course, if the bone is so extensively diseased that repair is unlikely, or if improvement does not take place under ordinary treatment, or if the amount of discharge is so great that there is risk of the general health failing, there should be no hesitation.

For other diseases excision is rarely necessary; but it may be performed f suppurating osteo-arthritis (in a patient sixty-three years of age under my c the result was most successful), and for chronic suppuration consequent upon in or pyæmia.

*In cases of deformity*, whether arising from old unreduced dislocation, fra ankylosis after inflammation, or from cicatricial contraction of the soft part excision often gives a very good result. The question as to its advisability turn upon the usefulness of the arm and the occupation of the patient. Bony ankylo at an angle of 75° to 80° is a wonderfully slight impediment to many people; o the other hand, if the angle is in the least degree obtuse, so that the patient ca neither feed himself with an ordinary spoon or fork nor place his hand at the bac of his head, the arm is almost useless.

**Operation.**—An elastic band may be applied around the arm, but the bleed ing is usually slight. The shoulder is raised on a pillow and the forearm held b an assistant. If the right elbow is in question, the arm should be held across th patient, with the olecranon presenting upward, the operator standing on the sam side, the assistant on the opposite one. If the left, it is more convenient for th surgeon to stand upon the right. A linear incision, four inches in length, is mad over the back of the joint, its centre corresponding to the tip of the olecranon It should lie just to the inner side of the middle of the arm and be carried righ down to the bone at once, splitting the fascia of the triceps longitudinally. Th next step is to detach from the bone the aponeurosis covering the back of th olecranon, first upon the outer side, then upon the inner, until the narrower pa of the process is reached. In cases of disease this is easily accomplished with blunt elevator, but in primary excision it is more difficult. If now the olecranon is cut across with a pair of bone forceps, the cavity of the joint is opened, th triceps and the posterior parts of the lateral ligaments are detached from the uln without risking the insertion of the muscle into the fascia, and abundant space obtained for separating the soft parts from the condyles.

This, especially in cases of injury, is the most tedious part of the operation The inner side must be cleared first, taking care of the ulnar nerve, which is seldom seen. The soft parts are raised with the thum from the bone beneath, and carefully sepa rated from their attachment with a sto scalpel, keeping the knife parallel to the nerv The external is treated in the same way, th assistant helping by keeping the arm as near vertical as possible. As soon as this is don the end of the humerus protrudes throug the incision, and the bone can be clear with ease as high as necessary. How muc should be removed depends upon the gene condition; the whole of the cartilagino surface should certainly come away, the li of section passing above the condyles; t the age of the patient, the cause, whethe injury or disease, and the state of the ar which in some cases of old ankylosis is grea wasted, must all be taken into considerati

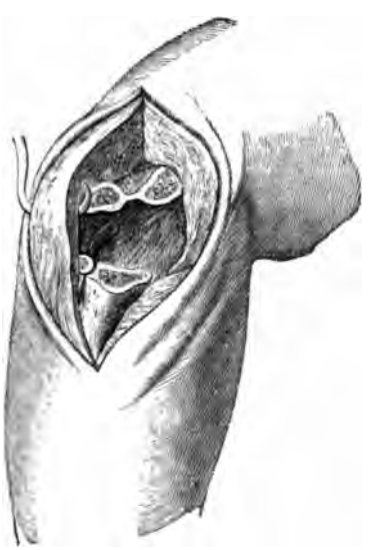

FIG. 278.—Section of the Bones in Excision of the Elbow Joint.

The stump of the olecranon and the he of the radius are then cleared in the same w and sawn across together, above the inserti of the biceps. It is often recommended open the joint above the olecranon, a remove the necessary portions of the ulna a radius first; but I have found the method described more expeditio

In tubercular disease the condition of the synovial membrane a

require attention. One or two small arteries may need to be tied or twisted, there is very little bleeding. The wound can usually be washed out at once with a hot solution of corrosive sublimate, and sutured, leaving an orifice in the middle for drainage, or better, a short drainage-tube.

Many splints have been devised for use after this operation (some surgeons use none at all); but as convenient a contrivance as any, at least while the patient is in bed, is an inside angular one, interrupted and hinged opposite the elbow, provided with a rounded end (as in Carr's splint) for the fingers, and with two cross-bars underneath, so that it may be slung from a pulley over the bed, and supported by a counterpoise of shot. With this the dressings are easily changed; the angle can be altered if required, the fingers can be exercised, and the patient can sit up and move about in bed without the least fear of disturbing the wound.

Passive movement of the fingers and wrist should be commenced at the end of the first week; the new joint need not be moved until the wound is nearly sound. If too little bone has been taken away, passive motion will not prevent osseous union. In some cases all the movements of the joint—flexion, extension, pronation, and supination—are almost perfect from the first; but these are the exceptions. In the majority there is very little power for some time, but gradually, as the muscles grow accustomed to their shortened position, and as the nutrition improves under the influence of galvanism, massage, passive motion, and exercise, the strength returns, and the range increases until it is almost, if not quite, as good as in the normal arm. This may take place even after a twelvemonth.

If the movement becomes restricted, in spite of passive motion, the question must be considered whether the operation should be repeated and more bone removed, or the limb allowed to become rigid (as it cannot be prevented) at the most convenient angle. If, on the other hand, a flail joint results, the usefulness may be greatly increased by providing the patient with a suitable leather or poroplastic splint, taking the whole of the arm and the forearm as far as the wrist.

### *Excision of the Wrist.*

This is very rarely required except for strumous disease. I have on several cases performed a partial operation in cases of injury, removing bruised and broken fragments of bone with a good result; but an accident that rendered complete excision necessary would almost certainly cause too great destruction of the soft parts.

It may be performed in various ways, but the two chief are those practiced first by Lister and by Langenbeck.

1. *Lister's Operation.*—Two lateral incisions are made; the whole of the carpal bones except the hook of the unciform and the osseous portion of the pisiform are removed, and five tendons only (the carpal flexors and extensors) divided at their insertion.

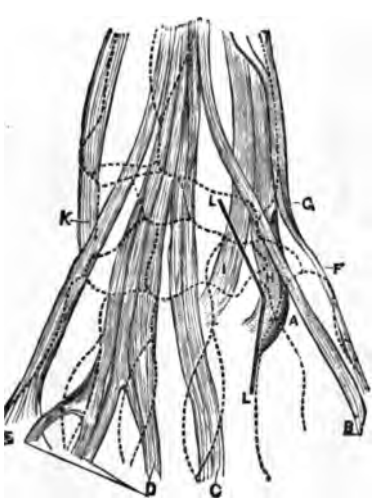

FIG. 279.—Lister's Incision for Excision of the Wrist.

Esmarch's bandage is applied and the adhesions broken down. The first incision begins on the middle of the dorsal aspect of the radius, on a level with the styloid process, and runs thence to the radial side of the base of the second metacarpal and along the bone for half its length. Its first part is internal to the extensor secundi internodii and it turns just before it reaches the radial artery. If carried down to

the bone at once it necessarily cuts across the extensor carpi radialis brevior; this may, however, be avoided with a little care and the tendon divided immediately afterward at its insertion.

The tendon of the long extensor of the carpus is then separated from its attachment; the radial artery with the tendons of the thumb drawn outward; the trapezium detached from the rest of the carpus with cutting-forceps, and all the tendons on the dorsal surface of the carpus raised from the bones beneath as far toward the ulnar side as possible. They should not be lifted out of their grooves on the radius.

The second incision is on the palmar aspect of the ulnar side. It begins two inches above the joint, internal to the flexor carpi ulnaris, and is carried down to the middle of the fifth metacarpal. The tendon of the extensor carpi ulnaris is cut at its insertion; the dorsal and internal lateral ligaments divided, and the raising of the extensor tendons completed by working toward the radial side.

The soft parts on the palmar surface are separated next, the pisiform bone with the tendon of the flexor ulnaris being detached from the rest and the unciform process cut off. The wrist in doing this must be flexed and care must be taken not to work down on to the metacarpus for fear of the deep palmar arch. The anterior ligament of the carpus is divided at the same time.

The carpal bones (except the trapezium) can now be extracted through the ulnar incision with sequestrum-forceps, the ends of the ulna and radius forced out, and their articular surfaces removed with a gouge or saw, as the case requires.

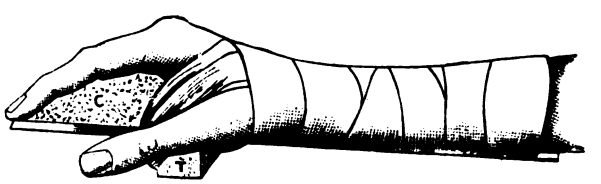

FIG. 280.—Lister's Splint for Excision of the Wrist.

The styloid process of the ulna should be left, and the tendons on the dorsum of the radius disturbed in their grooves as little as they can be.

The metacarpus is then treated in the same way: the trapezium dissected out, taking care of the tendon and the artery (if this bone appears fairly sound it may be left), and the articular surface removed from the pisiform bone.

Lister's splint, with a cork pad to support the fingers in semi-flexion, and a bar for the thumb, is nearly always used. The fingers and thumb must be thoroughly flexed and extended at every joint after the second day, in order that the tendons may cut channels for themselves in the vascular lymph that fills the wound; but the wrist itself must be kept at rest until union is assured.

2. *Langenbeck's.*—A single incision four inches in length is made along the dorsal surface of the wrist between the tendons of the extensor secundi internodii and the extensor indicis, commencing well above the wrist joint and ending at the middle of the second metacarpal bone on its ulnar side. The tendons on the radial side of the incision are then lifted up from the radius and the carpus, with the periosteum, so that the sheaths are not opened; the proximal row of carpal bones separated from each other and extracted one by one, beginning with the scaphoid, and then the second row treated in the same manner. It must be remembered that in cases of strumous disease the bones are softened; the ligaments for the most part easily divided; and the soft tissues around matted together so that they can be much more easily detached; otherwise this operation is one of considerable difficulty.

The cases for which excision of the wrist is required are few and far between.

young subjects, if caseation is not yet far advanced, a very great deal can be e by rest, tonics, and thorough general treatment, the joint being easily pro- ed afterward. If caseation and suppuration have occurred already, local rations, such as gouging out soft carious bone and packing the cavities with oform gauze, frequently suffice, and leave a very useful hand. In older people so often associated with phthisis that great care must be taken in the selection ases. The operation itself sometimes yields a very good result; but, on the er hand, not unfrequently all the tendons become matted together, or the ercular disease returns, or suppuration sets in, or the patient's health begins to and amputation has to be performed. In what proportion of cases this occurs s impossible to say, but there is reason to believe that it is a very large one.

### *The Thumb and Finger Joints.*

Excision of the metacarpo-phalangeal articulation of the thumb may be per- med without difficulty through a vertical dorsal incision. It is sometimes re- ired for compound comminuted fractures or old unreduced dislocations, and ves an excellent result. Occasionally a similar operation is advisable in injuries other joints.

## II. The Lower Extremity.

### *The Hip Joint.*

Excision of the hip is performed for compound comminuted fractures of the ad of the bone (such cases are very rare in civil life), as an alternative to am- utation, and occasionally for old unreduced dislocations. The total number of ese, however, is very small; nearly always, when excision of the hip is mentioned, e presence of tubercular arthritis is implied.

The operation may be performed either through an anterior or a posterior cision; the former is preferred if the disease is in its earliest stages, before sup- ration has occurred, and when there is reasonable hope of securing primary ion; the latter if the parts are disorganized and a large amount of discharge pected.

(1) *The Anterior Method.*—The patient is placed on his back with the limb ghtly flexed. The incision, three or four inches in length, is begun immediately ow the anterior superior spine and carried downward and a little inward, par- el and just external to the sartorius, so as to open up the capsule of the joint once between this muscle on the inner side, and the tensor fasciæ femoris and glutæus medius on the outer. A deeper incision is now made in the capsule, rallel to its fibres: the soft parts are pushed on either side with an elevator, the ger introduced to examine the part, and a narrow-bladed saw passed down by side on to the top of the neck. As soon as this is divided the head of the ur is grasped with a pair of forceps and twisted out. If the acetabulum or the at trochanter is involved, the carious bone is gouged away, and any caseous osit in the neighborhood thoroughly scraped out. Then the wound is washed with a hot antiseptic solution; dried thoroughly; dusted with iodoform and n up, leaving a drainage-tube of suitable size. As Barker has shown, the actual ity left by this operation is a very small one, and in a certain proportion of s primary union can be obtained. This, however, is only practicable in the ier stages of the disease.

(2) *The Posterior Method.*—The patient lies upon the sound side near the e of the table. The incision, three to four inches in length, begins about way between the anterior superior spine and the great trochanter, and, as bson recommends, is carried downward over the middle of the latter, so as nd upon the shaft. If it is taken round the trochanter, it encroaches upon the tance of the muscles. The capsule is opened freely by deepening the incision;

the soft parts are separated from the bone with an elevator, the periosteum as a rule coming away without difficulty, and as soon as the parts are sufficiently free the neck is divided with a keyhole saw. The finger should be used to protect the soft parts on the inner side. Afterward the condition of the acetabulum must be examined; any sequestra that are present removed; and if there is any evidence of a pelvic abscess (which may often be ascertained previously by rectal examination) sufficient of the floor taken away to ensure thorough drainage.

[These methods are vastly inferior to that of Koenig, which in every case where the trochanter is sound should be adopted in preference; or the method may be modified by the preservation of the entire trochanter. The operation as modified is performed as follows: A curved incision is made, commencing just below the crest of the ilium and directly over the trochanter major, and extending downward about two inches. The incision is deepened until the trochanter is exposed. By means of a chisel the trochanter is separated at its base from the shaft of the bone at the upper level of the neck of the femur. The trochanter, with the muscles intact, is now turned upward, and the neck of the femur with the capsule are exposed to view. Incise the capsule, examine the joint after irrigation. If there is much caries of the head of the bone, it may now be removed by a few blows of the mallet and chisel, dividing the neck close to the head, if the neck is sound, or close to the trochanters, if required. The acetabulum is now thoroughly scraped with the sharp spoon, and every vestige of diseased tissue removed. The cavity is now irrigated with iodine water, dried and packed with iodoform gauze, leaving a projecting portion behind the trochanter. The trochanter major is now brought down to the shaft and sewed down to the periosteum by two or three interrupted sutures of chromicized catgut. The wound is then closed by sutures, except a space behind the trochanter, where the gauze projects. The usual antiseptic dressing is applied, and rest secured by plaster-of-Paris splint. Extension should be continuously maintained during the healing process. By this operation the muscles are preserved in their integrity, and the motions of the limb after the operation are but little impaired.]

The after-treatment, whichever incision is practiced, consists in perfect rest in a position of extension with slight abduction. In the case of the anterior method a Thomas's splint may be applied after the first week.

The indications for this operation have been discussed already. By some surgeons it is performed as soon as caseation is certain; by others only as an alternative to amputation, when it is clear that the recuperative power of the patient unaided is incapable of dealing with the disease. The difference in opinion appears to have arisen chiefly from the difference in the conditions under which the patients are placed.

The results of the two operations naturally differ very greatly. An excellent limb is left after early excision, if the wound heals up at once; if it does not, and there is reason to believe that primary union is not invariable, the condition of the patient is very serious; but as yet hardly anything is known with regard to the ultimate effect, and this, of course, is the true criterion. Late excision undoubtedly leaves a wasted and shortened limb, but the credit of this must not be laid wholly at the door of the operation; had this not been performed, it is questionable whether the limb would have been any better, and it is quite possible that the patient would not have survived the prolonged suppuration without some amyloid degeneration. The comparison, if there can be one, should be made, not between the results of early and late excision, but between the results of early excision on the one hand, and those of the natural process of cure with a very few cases of late excision on the other.

### *Excision of the Knee Joint.*

Primary excision has been performed in a few cases of gunshot wounds, but the conditions under which so serious an operation is admissible are very rare. Chronic disease involving the bones is the general cause (erasion or arthrectomy

to be preferred as long as the soft parts only are concerned); osteo-arthritis, mited to one joint in a patient otherwise healthy and not too old; ankylosis in faulty position, and compound transverse fractures of the patella, in which it is impossible to bring the fragments together without shortening the limb, are occasional ones.

**Operation.**—Many different incisions are recommended by different operators, depending partly upon the advisability of removing or leaving the patella. The ordinary one is semicircular in shape, the bone being taken away.

It commences behind the condyle on the side that is furthest from the operator, passes down over the ligamentum patellæ, and is continued up to a corresponding point on the opposite side. The lateral ligaments are divided, but it should stop short of the internal saphena vein. The flap thus marked out is then reflected upward and the joint freely opened by a second incision convex upward, starting from the extremities of the first and carried through the tendon of the quadriceps above the patella. In many instances it is advisable to slit the tendon up still higher by vertical incision in the middle line. The whole of the great suprapatellar pouch must be exposed and thoroughly scraped out, and in the case of children suffering from chronic disease of the synovial membrane it not unfrequently extends nearly half-way up the femur.

The other incisions are transverse across the patella, opening the joint above and below the bone and removing it at once; transverse, dividing the patella in two, so that it may be wired together again afterward (this helps to prevent displacement of the tibia backward, but it renders the complete removal of all the pulpy tissue more difficult); and semilunar, across the tubercle of the tibia. This process belongs to the epiphysis and can easily be separated with a chisel (in many cases a stout scalpel will answer) carrying the ligamentum patellæ with it, so that the whole of the front wall of the knee joint is reflected in a single flap. Afterward if the patella is left, it may be fixed down again by means of a wire or chromic catgut suture.

As soon as the joint is freely opened the suprapatellar pouch must be cleared out, the rest of the soft structures being dealt with later. The femur is then pushed as far on the surface of the tibia as possible (the popliteal artery is well out of the way); a cut made through the soft tissues covering it for the saw, and the articular surface removed, the line of section being at right angles to the shaft (a little more usually has to come away from the inner side than from the outer) from above downward and slightly from behind forward. Butcher's saw may be used, but an ordinary one answers as well. The level of the epiphysis is marked by the adductor tubercle, and the incision should not be carried above this; if the disease extends higher, it must be scraped or gouged away.

The position of the bones is then reversed, the tibia brought in front of the cut section of the femur and the upper surface with the semilunar cartilages resting upon it sawn off. As a rule, it is sufficient to remove the articular lamella; if there is a soft or carious spot in one of the tuberosities it can be gouged out and an opening for drainage made through its base on to the anterior surface of the bone. The anterior crucial ligament must always be sacrificed, but in many cases it is possible to preserve the attachment of the posterior one, and if this can be done it renders the bones much more secure.

After this the synovial membrane covering the posterior ligament and that which lines the posterior pouches (often in these cases very much increased in size), can be dissected off or scraped away without difficulty. Every particle of soft tissue must be removed, as persistence of the tubercular growth is one of the main causes of failure.

If the posterior crucial ligament has been preserved the bones are fairly secure without anything else. Where it has been divided the cut surfaces may be sutured together with steel pins driven obliquely through both bones so as to cross each other near the line of union, or with wire silk, or stout chromic gut. Afterward one or two drainage-tubes must be inserted according to the amount of discharge

expected, the wound thoroughly washed out, all bleeding stopped, and the anterior flap adjusted and fastened down. A back splint interrupted opposite the knee and provided with a foot-piece to prevent any dropping of the toes, must always be used. It may be made of wood or of tinned iron, and it should be provided with two cross-bars, so that it can be slung from a pulley over the bed and supported by a counterpoise of shot. If this is well adjusted and the mattress cut away on the diseased side from below the fold of the buttock, the limb swings absolutely free, entirely out of the patient's control. It may be secured either with two interrupted side-splints like an ordinary compound fracture, or with a mixture of paraffin and wax applied hot, as recommended by Howse. In either case the fixation is absolute. Union is fairly sound in a successful case at the end of six weeks, and the patient may then be allowed to get about on crutches, the limb being protected either with a poroplastic casing or with Thomas's knee-splint. Some appliance of this kind must be worn for several years, in the case of children, until the period of growth has ceased.

The details naturally require modification in many particulars. The patella, for example, is sometimes preserved, its articular surface being thoroughly gouged away, or it is divided and sutured together again. Sometimes it is sufficient merely to shave off the ends of the bones, and occasionally the bones themselves can be left untouched, only the soft, pulpy synovial tissue being removed, as in erasion, but when this is done great care is required to prevent flexion afterward.

**Results.**—Excision of the knee rarely succeeds in patients over thirty years of age, or in those under ten; in the former the reparative powers fail, in the latter the growth of the limb is too much impaired. Puberty is the most favorable time. In some few cases a movable joint has been obtained (in erasion in which the articular surfaces are not taken away, this is usually the case, and sometimes the range is nearly as good as the normal one), but it is certainly wiser to try for bony ankylosis. Failure may occur from the whole of the tubercular disease not having been removed, from the strength of the patient being unequal to the strain, or from too much bone having been taken away. In this case, even if union does take place, the limb remains so weak and wasted, and is so much shorter than the other, that amputation is usually preferred. Later, even after years have passed, the osseous union sometimes yields and causes serious deformity —

### *Excision of the Ankle.*

This operation is rarely practiced; the reparative power of the foot is not very great, stability and firmness especially are required, and neither in the case of disease nor injury is the mischief likely to be limited. Compared with excision Syme's amputation involves very much less risk, and may be relied upon for an excellent practical result.

It may be performed either by two lateral incisions, or an anterior transverse one.

In the former (1) an incision is made on the outer side of the foot over the peronæi tendons, from two inches above the external malleolus to within an inch of the base of the fifth metatarsal bone. The skin and the periosteum are raised from off the bone, the tendons drawn to one side, the fibula divided at the upper angle, and the lower end drawn out from above and removed, dividing the external lateral ligament. The foot is then turned over and (2) an incision similar in length and direction made along the posterior margin of the internal malleolus, the tendons and periosteum being treated in the same way. The lower end of the tibia is then forced into the wound, by everting the foot, and removed with a narrow saw; the upper surface of the astragalus is treated in the same way, the whole of the gelatinous tissue scraped out, and the wound thoroughly washed out and drained. If the astragalus is much involved it is better to scoop it out of its periosteal shell altogether.

The anterior transverse incision is more simple. A cut is made across the

of the joint, beginning at the tip of one malleolus, dividing all the tendons, terior tibial vessels and the nerve, and ending at the corresponding point on posite side. The ligaments are then divided as far as may be necessary, the surfaces of the tibia and the upper of the astragalus successively exposed and ed, all carious bone gouged away with the granulation tissue, and then ndons and the nerve sutured together. The skin wound should unite by st intention. An outside angular splint, with the knee well bent, is the best nce until the seat of injury is partially consolidated and the discharge reduced ount, and after that a plaster or paraffin bandage, strengthened, if necessary, ps of tin.

# CHAPTER VII.

## *INJURIES AND DISEASES OF THE HEAD.*

## SECTION I.—MALFORMATIONS.

### ENCEPHALOCELE AND MENINGOCELE.

An encephalocele is a congenital tumor caused by the abnormal expansion of some part of the cerebral vesicles, so that the brain substance protrudes between the bones of the skull and prevents their proper development. In a meningocele the protrusion consists of dura mater and arachnoid only, but this is very much more rare. When in addition to the brain substance there is a great collection of fluid, causing immense distention of the ventricle, it is known as hydrencephalocele.

An encephalocele can only develop at those parts of the skull which normally contain processes of the ventricles; immediately over the nose, that is to say, corresponding to the anterior cornua (the exactly median situation is due to secondary growth of the bones); behind the mastoid process, where the lateral cornua come down; and in the neck and occipital region over the fourth ventricle. A few cases are recorded of a similar prolongation of the third ventricle into the pharynx, through the sphenoid, or between it and the ethmoid. Encephalocele has nothing to do with the fontanelles.

The occipital is the most common, the portion of the occipital bone between the inion and the foramen magnum being deficient. The frontal comes next; the others are very rare. Many cases of supposed meningocele, especially in the occipital region, are in all probability encephaloceles in which the brain substance has either atrophied or has never been developed. Hydrencephalocele explains itself.

FIG. 281.—Meningocele at Root of Nose.

An encephalocele forms a roundish, sessile, or pedunculated tumor, of very variable size (sometimes a mere nodule, sometimes larger than the rest of the child's head) projecting from the surface of the cranium. The skin covering it is generally normal, but it may be excoriated; and, when the distention has taken place very early in life, so that the development of the dorsal mesoblastic plates has been checked, it may consist merely of the undifferentiated brain tissue and meninges, covered over with epidermis, as in some analogous cases of spina bifida. It swells up and becomes tense when the child cries, and usually admits of partial reduction on pressure, although this may cause convulsions and other cerebral symptoms. Occasionally the outline of the opening in the cranial bones can be felt distinctly.

An encephalocele is usually opaque, with indistinct fluctuation, and is only partially reducible; and it pulsates distinctly. A true meningocele is always small and as a rule pedunculated; its contents admit of complete reduction, and, if it is large enough it is perfectly translucent. Hydrencephalocele is always very large and unusually pendulous, the rest of the child's head being ill-developed.

In some instances, particularly when the tumor is situated over the glabella and the skin covering it is red and vascular, great care is required to distinguish it from a nævus. They are both congenital and reducible; they both swell up

ı the child cries; the color is the same; and if the intracranial tumor is a
l one, reduction of its contents need not be followed by any cerebral symp-
; and it need not exhibit any arterial pulsation. I have known the diagnosis
undecided by surgeons who were
.inly capable of discriminating, if any
.

Fig. 280.—Encephalocele.

**Prognosis.**—If the protrusion is
l and the skin covering it healthy, it
not interfere with life; and in a few
cases it has happened that as growth
eeded the neck of the tumor has be-
e more and more constricted, until at
th it ceased to have any connection
the interior of the skull. Large ones
rule continue to increase until they
ure.

**Treatment.**—The growth should be carefully protected from injury and otherwise interfered with except under one condition—that it is on the point upture. Repeated tappings and injections of Morton's fluid have succeeded ases of meningocele, as in spina bifida; but, except in those instances in which ı the small size or pedunculated character of the tumor there is some prospect atural cure, the probability of a good result is very remote.

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## SECTION II.—INJURIES OF THE HEAD.

These include injuries of the scalp, of the bones, and of the brain.

The scalp may be bruised or cut; there may be hemorrhage, either externally into the tissues; the pericranium may be stripped off, the bone bruised or :tured; blood extravasated between it and the dura mater, or between the nbranes, of the brain; and the brain itself contused or torn. No wound or w, however slight, should be neglected; even when the superficial structures e escaped unhurt there may be serious injury to the much more important s beneath. Afterward inflammation may set in, even though there is no ex- ıal wound. If this occurs it may attack the scalp or the loose cellular tissue eath; it may begin in the bone, causing osteophlebitis and necrosis, and end- either in general pyæmia or in thrombosis of the sinuses, inflammation of the nbranes or cerebral abscess, according to the method of its extension; and lly it may start in the brain itself.

### Injuries of the Scalp.

The scalp presents certain anatomical features of considerable surgical im- ance. The skin in the first place is so closely bound down to the aponeurosis ath, that merely cutaneous wounds never gape, and superficial inflammation :ver attended by much swelling or redness. For the same reason contusions ı cause what apparently are incised wounds. Further, the chief vessels lie een the aponeurosis and the skin, and are imbedded in such dense tissue that ı they are cut they cannot retract, and can hardly be tied. On the other l, beneath the aponeurosis the tissue is so loose that blood or pus can collect the skin floats as on a water-bed, bounded by the zygoma, the eyebrows, and uperior curved line; and the scalp can be stripped off and hang down in

flaps. Sloughing, however, owing to the position of the vessels, is rarely ca[used] in this way. Finally, the pericranium is easily separated from the bone, exc[ept] at the sutures; it only supplies the outer table, not the diploë or the inner, so t[hat] when necrosis occurs from this cause the sequestrum is usually superficial. It [is] peculiar also that it hardly ever produces any new bone to repair an injury.

### *Contusions of the Scalp.*

The blood may be extravasated (1) in the scalp itself; (2) in the sub-aponeurotic layer; or (3) between the pericranium and the bone.

The first, owing to the denseness of the tissue, is always insignificant. The second may be either diffuse, and of enormous extent, or circumscribed, and then very often it is curiously deceptive. The blood around the margin coagulates into a hard, dense ring, the inner edge of which is sharp and well-defined, while the outer is beveled off; in the centre it remains fluid, so that when the finger is pressed upon it the margin stands out as clearly as the edge of a depressed fracture, for which it may easily be mistaken. The ring, however, is distinctly raised above the level of the surrounding bone, and it can always be indented. I have known the opposite mistake made. Abscesses sometimes give rise to the same kind of impression, and it must be remembered that the presence of a hæmatoma does not exclude the existence of a fracture.

The third (cephalhæmatoma) only occurs in infants and nearly always from injuries received at birth. It is most common on the parietal bone, though I have seen it on the occipital, and it is easily recognized by the way in which it is limited to one bone; it never extends over the sutures. Like the former, the margin becomes hard, and a certain amount of organization, and even ossification, takes place; the centre remains fluid, and for a long time gives rise to a sensation of parchment crackling when pressed upon.

Absorption in all these cases is slow, but, unless inflammation sets in, they should never be incised; and aspiration is rarely necessary. The cephalhæmatoma of infants should never be touched; in other cases lead lotion may be applied at first, or, if the patient will lie down, an ice-bag, to check the extravasation and hyperæmia; afterward well-applied pressure is the most efficient remedy.

### *Wounds of the Scalp.*

These, like contusions, may be superficial, involving the skin only; or extend into the subaponeurotic layer; or lay the bone bare. The first are rarely of any extent; in the second, if the hair is entangled in machinery, or the head caught under a cart-wheel, the whole scalp may be detached and hang down in a flap, but it rarely sloughs; in the third there is an additional danger, for the bone is exposed, and is often bruised or scratched. Hemorrhage from the torn vessels is often abundant, but neither ligature nor torsion is of any use. Pressure stops it at once. Acupressure may be used, but a bandage is nearly always sufficient; care, however, is necessary, as it may be applied so tightly as to cause a slough.

**Treatment.**—Scalp wounds require no special treatment, the same principles must be followed as elsewhere; the only peculiarities are the extraordinary vitality of the skin, and the ease with which inflammation, if it once sets in, spreads in all directions. Therefore no portion of scalp should ever be sacrificed, no matter how bruised or dirty it is; and perfect cleanliness and perfect drainage must be insisted on. If this is carried out, they may be treated like other wounds, and with exceptional success.

The head must be shaved around the injury, the wound carefully explored and wash d out thoroughly with an antiseptic, all oozing stopped, and any bagging or collecting of fluid prevented. Counter-openings may be made and drainage-tubes inserted, if there is a dependent pouch; but in most cases it is sufficient to support the skin well against the skull so as to keep it at rest and ensure early

hesion. Then the edges of the wound may be dusted over with iodoform and vered with an absorbent dressing, such as wood-wool, or a sponge wrung out of bolic solution. There is no objection to the use of sutures, if care is taken; but course, if the wound is tightly sewn up, and suppuration allowed to take place eneath, serious consequences must ensue. Even if half the scalp is stripped off nd hangs down the back of the neck, or over the face, it may be treated in this ay, and often will adhere at once. If it does not, the under surface throws out ranulations, and union takes place by the third intention. In all cases of severe injury the patient should be confined to bed, and kept perfectly quiet, on low diet; and care must be taken that the bowels do not become confined. It must never be forgotten that, in addition to the scalp wound, there may be very great injury to the brain.

So long as there is no pain or fever, the wound should be left alone. If, however, one spot is tender, or if the temperature rises, or if there is any shivering, it must be exposed at once and carefully examined; it nearly always means that some of the secretion is pent up. As a rule it is sufficient to introduce a probe or to loosen a suture: a drop or two of fluid escapes and the symptoms are relieved at once.

Erysipelas sometimes attacks scalp wounds, but they are not more liable to it than others that are equally exposed. The danger is that the superficial wound may close, and the discharge collect and decompose beneath. The cellular tissue is so loose that suppuration soon spreads all over the head; the scalp becomes boggy and œdematous; the eyelids are swollen and the forehead reddened; the pulse becomes quick and feeble; the temperature rises; delirium sets in; and the condition becomes one of extreme gravity. If left to itself the whole of the cellular tissue may slough, leaving the bone absolutely bare; or the patient may sink from exhaustion or septic poisoning (especially as this is likely to occur in those whose health is broken down), or the inflammation may spread along the emissary veins into the diploë and sinuses of the cranium, and set up thrombosis and pyæmia. In such a case the wound must be laid open at once, only such sutures being left as are absolutely necessary to prevent a flap hanging down; small incisions, parallel to the main arteries and going right down to the bone, made wherever the skin is boggy; and warm boracic fomentations applied, to encourage the discharge as much as possible. Quinine and carbonate of ammonia are nearly always required; it is very seldom that any food can be taken; and in many cases the condition of the pulse is such that stimulants must be given freely.

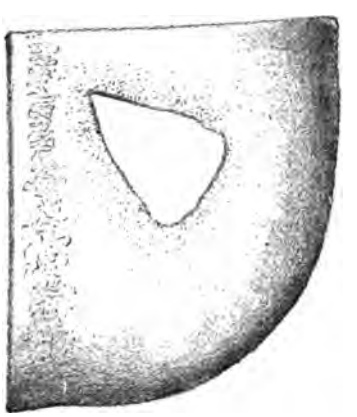


Fig. 283.—Exfoliation of a Triangular Plate of Bone from the Vault of a Skull, caused by denudation, three weeks after the injury.

When the pericranium is detached the risk is greatly increased. Necrosis of the outer table may occur simply from its blood-supply being cut off; more frequently it becomes vascular and throws out granulations, minute red dots making their appearance on the bare white bone, and projecting more and more as the compact tissue becomes absorbed, until they form a perfectly uniform layer. Or worse than this may happen: inflammation may set in. If this occurs, the whole thickness of the bone is most sure to perish, and the mischief may extend to the membranes of the brain into the venous sinuses, and cause either diffuse meningitis or general constitutional infection. Every case of scalp wound in which the bone is exposed requires to be watched with the greatest care.

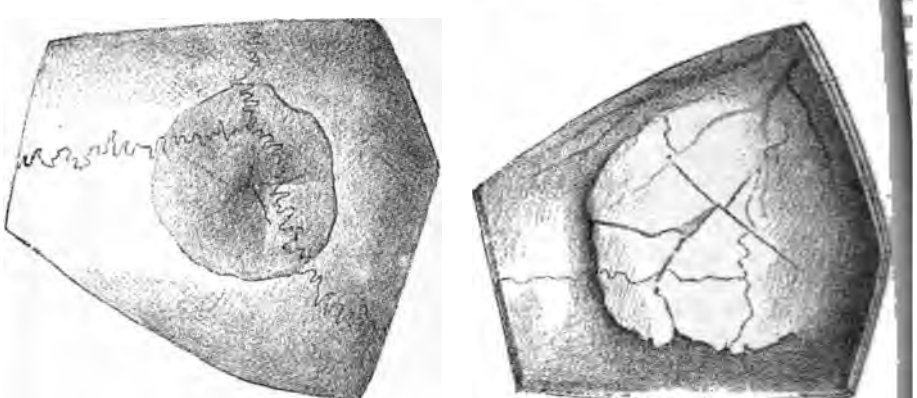
## Fractures of the Skull.

These are divided into fractures of the vault and fractures of the base. They are nearly always the result of direct violence. If the area on which the blow falls is limited, the injury is limited too; and naturally this is more common on the vault. If, on the other hand, the force is diffused over a wider area, the cranium is compressed, the most inelastic and unyielding part gives way, and a fissure is produced which generally runs across the base and part of the vault as well. The distinction, therefore, is not perfect, but it is found to work conveniently.

### 1. *Fracture of the Vault.*

Owing to its arched shape, its elasticity even in adults, and the presence of sutures breaking up and softening the force of blows, this escapes more frequently than might be expected. In infants it is sometimes bent in like a piece of tin, without any actual tearing, but in many of these cases the inner table gives way, as in greenstick fracture.

The fracture may take the form of a simple fissure, or it may be stellate or comminuted. Occasionally the outer table only is hurt, and a few rare cases are



Figs. 284 and 285.—Fracture of Vault of Skull Caused by the Impact of a Blunt Instrument (a hammer), showing the greater area and more extensive splintering on the inner surface.

recorded in which this has escaped, and the inner only has given way, but nearly always it extends through the whole thickness. If the bone is driven in, the fracture is said to be depressed; in most instances the whole substance is forced in, but over the frontal sinuses, and in contusions, the inner table may not be affected; generally it is splintered a great deal more than the outer. In children, owing to the elasticity of the bones, depression may take place without fracture, especially if the area is extensive, but probably in many of these there is really some tearing of the inner layer. Elevated fractures, caused by oblique cuts, are rare in civil life, and can only occur while the bones are still capable of yielding. Punctured fractures, which are produced by the impact of some sharp body, such as a nail, are particularly serious, owing to the amount of injury inflicted on the inner table. There may be only a small, round hole in the outer, while the inner is fringed all round with a row of spikes, projecting at right angles from the surface into the dura mater. The inner table, as a rule, splinters more readily than the outer, partly because it is thinner and more brittle, and forms part of a smaller circle, but mainly because, in all ordinary accidents, the blow falls upon the outer first, so that the force, in traveling through the diploë, becomes distributed over a wider area (Figs. 284 and 285). If a bullet passes through the cranium from within outward the reverse is the case.

### (*a*) *Simple Fractures.*

Of themselves, simple fractures of the vault are of little or no consequence; contusions, fissures, and fractures without displacement do not admit of proof, and even when the bone is comminuted and the depression considerable, the diagnosis is often only a conjecture, owing to the amount of blood extravasated. Their gravity arises from the fact that serious injury to important structures is so often associated with them. Concussion or contusion of the brain, hemorrhage between the membranes, or, especially if the course of the fissure traverses the middle meningeal artery, between the dura mater and the bone, rupture of the venous sinuses and laceration of the membranes are of frequent occurrence after simple fractures; more rarely the contents of the cranium (the cerebrospinal fluid at least) find their way out, and form a soft, fluctuating and pulsating swelling underneath the aponeurosis—cephalhydrocele.

Later, especially in cases in which the bone is severely contused, inflammation may set in, though it is very rare in comparison with compound fractures. It may be either acute or chronic. In the former case the whole thickness of the bone perishes, lymph is poured out beneath the pericranium, the scalp becomes boggy and œdematous (Pott's puffy tumor), and suppuration follows and spreads to the inner surface of the cranium. A few cases are on record in which the abscess resulting from this has been merely local, between the bone and the dura mater; much more frequently the inflammation rapidly involves the venous sinuses, and ends in either diffuse suppurative meningitis or pyæmia.

Chronic inflammation is even more uncommon, but an extraordinary thickening of the bone is said to have occurred after simple fracture. The whole skull may be affected, or irregular nodules may grow out and cause constant wearing pain and neuralgia. Loss of power, partial paralysis, and even insanity or epilepsy have been known to follow.

### (*b*) *Compound* (*Open*) *Fractures.*

In the majority of instances the nature of the injury can be seen at once. There is a fissure, appearing as a thin, red line, out of which blood continues to ooze, contrasting with the white bone around, or the bone is plainly comminuted and driven in, or the broken edge of a knife or other foreign body can be seen upon the surface. But this is not enough; the wound must be carefully and thoroughly explored with the finger, the mere diagnosis is not sufficient; its extent and the depth and character of the displacement must be made out as accurately as possible, especially in the case of punctured wounds. There are many sources of fallacy; a suture can be easily mistaken for a fracture, or the edge of a pericranium, if it is cut and one side is adherent to the bone, may feel like a fissure, especially if a probe is used. The temporal aponeurosis has before now given rise to difficulty: a foreign body may be broken off flush with the surface so that it can scarcely be detected, or, as in the case of the frontal sinuses in men, though the outward depression is very considerable the inner table may not be injured at all.

Serious complications are much more common in compound fractures. In the first place, the force is often greater, and nearly always is concentrated in one small spot, so that the inner table is driven inward and extensively splintered. The more nearly a fracture approaches the punctured form the more dangerous it becomes; it does not matter so much if the depression is wide and extensive, or if, owing to the softness and elasticity of the bones there is little or no splintering; the dura mater is not injured, and symptoms of compression, merely from displaced bone, are exceedingly rare; but where the inner opening is fringed with a circle of little spikes projecting vertically inward, and tearing and irritating the membranes and the brain, inflammation is almost certain (Fig. 286). In addition, compound fractures are always exposed to the risk of

decomposition. Blood is extravasated into the diploë, and between the dura mater and the bone; the fracture is often comminuted; there are numerous little spaces and fissures between the fragments which cannot drain, and the wound is frequently filled with dirt and other foreign substances. Under these circumstances unless steps are taken to prevent it, inflammation must break out, and though fortunately it often remains limited to the wound, and merely causes necrosis of the broken fragments, it may at any moment spread into the surrounding bone, or, especially if the dura mater has been pricked, into the membranes of the brain, and set up fatal meningitis.

FIG. 286.—Punctured Fracture of Skull.

**Treatment.**—(*a*) *In Simple Fractures.*—So far as the bone itself is concerned, injury to the vault of the skull rarely requires anything. Unless there are definite symptoms of compression, either growing worse or refusing to clear up, nothing should be done. But it is so often associated with concussion and contusion of the brain, and the extent of the injury is so entirely unknown, that in any case in which there is the least ground for suspicion the utmost precautions must be taken. The patient must be placed in a darkened room with the head shaved, and an ice-bag, or, better, Leiter's coil applied; every source of irritation or excitement should be excluded, the bowels should be opened, preferably with a calomel purge, and nothing but the simplest diet allowed. Rest in bed must be strictly enforced for at least three weeks, and the patient must be carefully watched for months. The great fear during the first few days is that hyperæmia and inflammation of the brain may occur; after that the chief risk comes from the bone, which may inflame and cause necrosis, meningitis, or pyæmia; still later, even years after, symptoms of cerebral irritation may make their appearance, sometimes merely undue excitability or fits of temper, especially if there is any indiscretion in diet or abuse of stimulants; occasionally, but fortunately very rarely, more serious trouble, such as epilepsy and even insanity.

(*b*) *In compound fractures* the wound in the soft parts and the injury to the bone require something further. The former should be treated as already described; the hair should be shaved off, the scalp well-washed, the hemorrhage stopped, foreign matter and dirt carefully removed, and then all the part that has been exposed thoroughly washed out with corrosive sublimate or some other antiseptic. It should then be well dried, the edges dusted over with iodoform and brought together with sutures (catgut is especially useful where there is no tension), leaving suitable openings for the escape of the lymph, and if necessary one or two tubes may be inserted. Then it should be carefully covered over with a thick layer of some dressing sufficiently absorbent to soak up any discharge at once, and bandaged to avoid displacement and secure rest.

*Simple linear fissures*, not depressed and not caused by the impact of a sharp weapon, may be covered in at once, the pericranium being replaced if it is torn off. There is no splintering in such a case, no fear of spicules irritating the dura mater and the brain, and the sooner the fracture is converted into a simple one the less the risk of decomposition and suppuration. *Punctured fractures*, on the other hand, should always be trephined, the wound in the outer table being included in the circle of the instrument. It is impossible to ascertain the condition of the inner table; in nearly every case it is starred and the splinters driven inward; the operation adds nothing to the gravity of the case, and deep punctured wounds passing through strata of different consistence cannot either be cleaned or drained.

*In compound depressed fractures*, portions of bone that are detached or loose or driven into the substance of the dura mater, must be carefully picked out. If there are symptoms of compression, or if the size and depth of the wound make it probable that the inner table is splintered, the bone must be elevated,

it, if necessary, part of a circle removed with the trephine, the pin resting on the uninjured margin. No pains must be spared to make the elevation effectual, and to exclude the possibility of splinters being left under the overhanging edges. It is true that a large proportion of patients never suffer in any way; that fragments of bone and even foreign bodies have remained embedded in the substance of the brain itself for years, without its being known; but they are never safe. So many cases are recorded of disturbances of the most varied character—motor, sensory, and psychic—being caused by the presence of a depressed fracture, and being cured by its elevation, that unless the depression is smooth and even, as it nearly always is in children (fractures of the skull in them rarely require much interference), it is better to raise it at once. The operation does not increase the patient's risk; trephining, when done as a precaution and not as a last resource for a disease that has almost proved fatal already, is very rarely followed by any ill result; and in many cases in which the wound, filled with extravasated blood, has been exposed to the air, and perhaps ground in with dirt, the cleansing process cannot be thoroughly carried out, or the risk of decomposition and inflammation avoided, without its being done.

Sometimes it is merely necessary to introduce the point of an elevator under one of the edges of a depressed fragment, and gradually lever it up until it is on a level with the rest. Very often, however, the fragments are so locked together that this cannot be done without first removing a portion of bone; or it is found that the injury is much more extensive than it appeared to be at first sight, and that the splintering extends a long way under the edge of the outer table. Then it becomes necessary either to remove some of the overhanging edge with Hofmann's gouge-forceps (or Keene's vongeur), or to apply the trephine on the margin. In any case great care must be taken to preserve the pericranium and to avoid detaching any adherent fragments. The wound must be dressed in the ordinary way. The portion of bone that has been removed may be replaced, and in some cases it retains sufficient vitality to form fresh adhesions; more often it gradually becomes absorbed, or, if suppuration sets in, perishes and is thrown off as a foreign body. It very rarely happens that there is any reproduction of bone; the edges of the opening become rounded and smooth, and a dense fibrous cicatrix forms upon the surface of the dura mater, strong enough of itself to act as a protection to the brain, unless the opening is very large.

### 2. *Fracture of the Base.*

Fracture of the base of the skull is sometimes the result of direct violence—when, for example, a revolver is discharged into the mouth, or a stick is forced through the roof of the orbit, or the condyle of the jaw is driven through the glenoid fossa. More often it is caused by a fissure extending from the vault. The fracture starts from the point that is struck, and generally passes across the base of the corresponding fossa, sometimes when the force is great involving more than one. The middle suffers the most frequently, as might have been expected, and a very common course for the fissure to take is across the petrous portion of the temporal bone and the internal auditory meatus. Occasionally it is produced in other ways. The skull, for example, may be driven down on to the vertebral column, as a hammer-head is forced on to the shaft, with such violence as to break the bone round the foramen magnum; or, as it falls upon the head, the vertebral column may be driven against the skull. In fracture by *contre-coup* the injury is on the opposite side of the head, at the other end of the diameter. The orbital plate of the frontal bone, for example, is sometimes fissured from a fall upon the occipital region. The skull is suddenly shortened in its antero-posterior diameter, and correspondingly widened in its lateral and vertical ones; both the frontal and the occipital regions are flattened out; but the former, being the thinner, more brittle and less regular in its elasticity, gives way first. It must not be forgotten that fractures extending into the ear, nose, and pharynx are really compound.

The diagnosis of fracture of the base of the skull can only be made either from an escape of some of the contents of the cranium, or from injury to some of the structures that pass out through it. It may be suspected whenever there is evidence of serious injury to the brain after a severe blow upon the head, but it can only be proved by one of these. Probably it is present in many of the cases of severe contusion to the brain, in which the patient, after lying in a state of semi-unconsciousness for days and even weeks, slowly recovers. If it is compound, it adds very distinctly to the danger of the case.

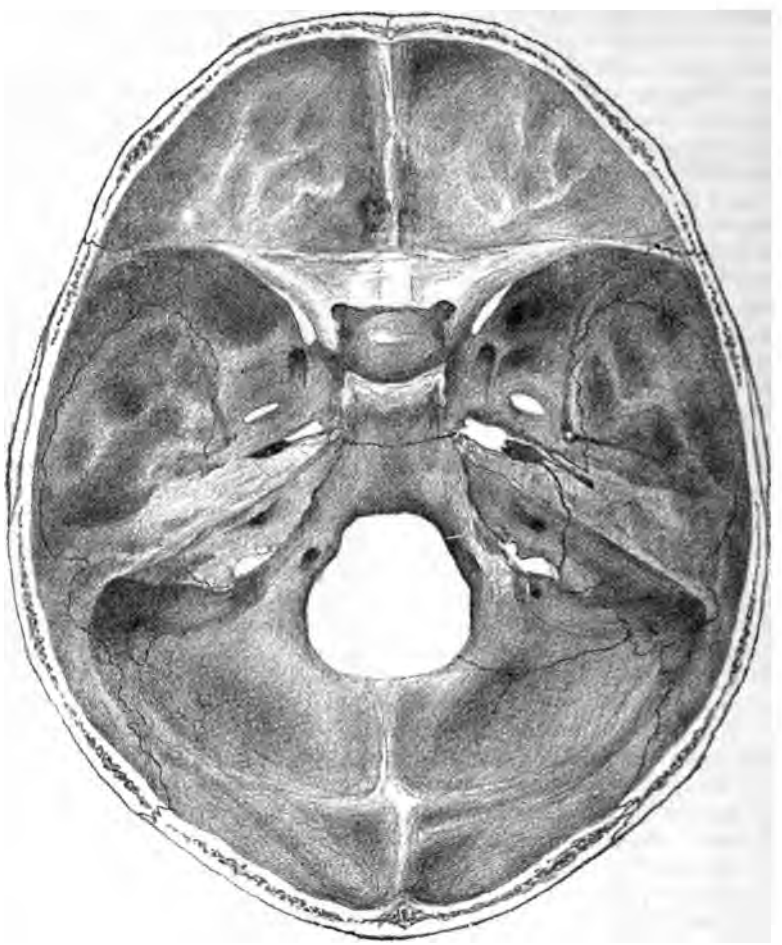


FIG. 287.—Base of Skull showing the most frequent Lines of Fracture (*a*) across the petrous portion of the Temporal Bone, cutting the Internal Auditory Meatus in two, (*b*) passing between the Foramina media, and (*c*) radiating from the Foramen magnum into the thin bone of the Occipital Fossa.

*The brain substance itself* rarely escapes, except in gunshot injuries and compound fractures through the ethmoid, when, for example, there is a violent blow at the root of the nose breaking up the cribriform plate and lacerating the dura mater. The ordinary signs that are looked for are the escape of cerebro-spinal fluid and hemorrhage.

*Escape of Cerebro-Spinal Fluid.*—This may take place, as already mentioned, on the vertex, coming from the ventricles of the brain, and forming if the fracture is a simple one, a soft, fluctuating, and pulsating swelling, which causes symptoms of compression when it is reduced; or it may escape from the ear, the nose, or

roof of the pharynx. Owing to the frequency with which fractures of the middle a of the skull pass across the internal auditory meatus and tear open the progation of the arachnoid along the auditory nerve, the ear is by far the most com- n of the three. If the tympanic membrane is torn across, it pours out from the ernal meatus; if it is not, it trickles down the Eustachian tube into the pharynx l probably escapes notice altogether. In the case of the nose and pharynx it st come from the great sub-arachnoid sac at the base of the brain, possibly along course of the olfactory nerves. In one or two instances the fissure in the rous portion of the temporal bone has been so fine that it could only be detected er maceration.

The nature of the fluid may be recognized partly by its quantity, partly by chemical composition. The escape of a teaspoonful of moderately clear fluid m the ear, a day or two after a severe blow on the head, cannot be regarded proof of fracture of the base of the skull. If the tympanic membrane is torn ross, there is often, especially in men, a certain amount of secretion of a watery id from the mucous membrane lining the mastoid cells; but this does not come i immediately after the accident, and, like catarrhal secretion generally, is al- ays more or less turbid. It is possible the same thing may occur in connection ith the frontal sinuses. Cerebro-spinal fluid begins to escape either at once or mediately after the hemorrhage has ceased, and as much as a pint may flow out twenty-four hours. Usually it continues for several days and then ceases of itself. hat it comes from the interior of the cranium may be shown by making the tient blow his nose hard, compressing it at the same time; the intra-cranial pres- re rises rapidly and the fluid pours out; but the experiment is not advisable. Its emical composition agrees perfectly with that of cerebro-spinal fluid; there is appreciable amount of chloride of sodium present; a trace of sugar can some- nes be found; but the amount of albumin is much too small to give any reaction th nitric acid, or acetic acid and ferrocyanide of potassium, even when the fluid s been concentrated at a low temperature.

*Hemorrhage* naturally is more ambiguous. The mere escape of blood after evere injury to the head cannot be regarded as a diagnostic sign of any value, less there are special features in connection with it. Every case of hemorrhage m the ear, for example, must be looked upon with grave suspicion, unless it can traced to some small laceration; but it can only be regarded as a proof of acture when it is immediate, copious, and long continued. The same thing may said of hemorrhage into the tissue of the orbit. If the stain does not make appearance under the conjunctiva for some time after the accident, and if it adually creeps forward toward the cornea (not, as in an ordinary black eye, from rect injury, diminishing as it recedes), it is proof that the hemorrhage comes m behind, possibly from fracture of the orbital plate of the frontal bone; and it slowly soaks forward into the eyelids, the lower first, until they are both jet ack, without any staining of the cheek or forehead around, or if the eyeball protruded, it becomes much more definite. But it is only certain when the na- re of the accident is such as to preclude the possibility of any direct injury to e structures in the orbit itself. Under such conditions, serious hemorrhage ming from behind can only arise from a fissure traversing the orbital plate of the ntal bone or part of the sphenoid, and opening up, perhaps, the anterior ex- mity of the cavernous sinus.

Hemorrhage into the nose or mouth, or into the tissues at the back of the k, and vomiting of blood after any severe injury to the head, in the same way st be regarded as very suspicious, and any case in which they occur must be en the benefit of the doubt, and treated as if it were certain that there were a cture of the base; but they cannot be regarded as proof, unless the presence of other injuries can be excluded.

*The cranial nerves* may be injured in fractures of the base of the skull; ier torn, when the effect is immediate and usually permanent, or merely com- ssed by blood extravasated into the sheath or into one of the bony canals.

Sometimes this is followed by neuritis, coming on after an interval of two or three weeks, and gradually disappearing again. The seventh nerve suffers the most frequently, causing deviation of the soft palate, as well as facial paralysis; but atrophy of the optic disc, from rupture of the optic nerve, has been found after fractures of the anterior fossa, and occasionally the fifth and the motor nerves of the eye are involved.

Fractures of the base of the skull must be treated in the same way as fracture of the vault; the brain is always severely injured, and the greatest care must be taken to ward off any source of irritation. If the cribriform plate of the ethmoid is comminuted, an attempt should be made to remove the fragments, either through the orbit or the nose, for fear of the dura mater being injured, and to insure more perfect drainage. The discharge is certain to become purulent [unless drained and antiseptically irrigated], and is usually exceedingly offensive, especially if the injury is followed by necrosis. In the case of the ear, the meatus should be gently syringed out with an antiseptic, and then covered with a large pad of absorbent cotton, renewed as often as required. The fracture is compound, but meningitis rarely follows.

Callus is scarcely ever thrown out, the parts lie absolutely quiet, and there is no irritation; in many cases union is by fibrous tissue only; and the edges of the fracture become smoothed down and absorbed to some extent, so that the fissure, when the skull is macerated, appears much larger than it really was.

## INJURIES OF THE BRAIN.

The brain may be injured by concussion, contusion, or compression; blood may be extravasated between the membranes or in the substance of the brain itself, and the cranial nerves may be torn or crushed at their origin. The symptoms and diagnosis of these affections must be considered separately. The treatment may be dealt with as a whole.

### Concussion.

Concussion is the effect produced by a blow upon the head sufficiently severe to affect the functions of the brain, without causing any considerable alteration in its structure. There may be merely a temporary sensation of giddiness; or the patient may lie for hours in a state of semi-unconsciousness; or, rarely, the depression may prove fatal, without reaction ever setting in.

Opportunities for examining the condition of the brain are so rare that very little is known about the pathology of concussion. Minute ecchymoses and small points of contusion are found in the majority of instances; but, as the symptoms subside long before these disappear, they can scarcely be regarded as the cause. A certain amount of congestion is nearly always present, arising from paralysis of the walls of the vessels; and in all probability this is the immediate source of the functional depression. The rapidity with which recovery takes place as soon as reaction sets in, and the peculiar irritability that follows, point distinctly to some altered condition of the circulation. It has been shown experimentally that violent vibration, or even a slight degree, provided it is long continued, is capable of suspending more or less completely the activity of nerve-cells. If the cortex only is affected, the depression is merely transient and the symptoms soon disappear; but if, in addition to this, the ganglia at the base of the brain are involved, particularly the vaso-motor and the cardiac centres, the effect is more general and more lasting. The walls of the vessels everywhere, those of the cortex included, are relaxed; the blood-pressure falls; the blood lies stagnant in the great veins of the abdomen; the surface becomes cold and white; the temperature of the skin is lowered; and the pulse is rapid and feeble. In short, all the symptoms of severe shock are present, with the cerebral ones strongly accentuated.

**Symptoms.**—In the slighter cases there is merely a little transient giddiness

r confusion; when the injury is severe, the symptoms may be divided into four ages—collapse, rallying, reaction, and convalescence.

The first is characterized by depression, general and extreme, beginning at once and sometimes proving fatal, as the action of the heart becomes more and more feeble. The patient lies without moving, but the attitude is not that of utter helplessness; consciousness is not lost, though no notice is taken of anything; he can easily be aroused so as to speak, and move his limbs, but only for a moment; the skin is cold, pale, and clammy; the temperature low; the pulse feeble and rapid, sometimes intermittent, or so faint that it can scarcely be felt; the respiration shallow, with occasional sighing; the eyes glassy and devoid of expression; the pupils either contracted or dilated; the sphincters relaxed, and reflex excitability almost abolished. Then, after an interval that varies from a few minutes to several hours, the second stage begins; the heart begins to recover; the cardiac and vaso-motor centres regain their power; the pulse becomes fuller and stronger; the surface grows warmer; the brain is better supplied with blood, and sensibility rapidly returns. Very often at the same time there is vomiting, partly due to the fact that digestion has been interrupted, partly to the recovery of the pneumogastric centre; and the reaction is assisted by the compression of the abdominal veins driving the blood into the circulation.

The third stage, that of reaction, is scarcely noticeable in slight cases, especially in children; there is merely a little restlessness or irritability, often put down to temper. In the more severe ones, however, after twenty-four or forty-eight hours the symptoms change their character completely. The circulation becomes quickened; the amount of blood that flows through the brain is immensely increased; the head begins to ache and throb; the carotids beat so that they can be seen; the face is flushed; the skin becomes hot and dry; the eyes cannot face the light; there are noises in the ears; sometimes there is extreme drowsiness, so that the patient lies for hours in a semi-torpid condition, curled up in bed away from the light; sometimes there is great irritability or even wandering. In short, here are all the symptoms of hyperæmia of the brain, such as are met with in the early days of inflammation.

Gradually, in the course of a few hours, this begins to subside and convalescence sets in; very rarely, considering how common concussion is, it runs on to inflammation, but it is often months before the cerebral circulation is thoroughly under control and is able again to regulate itself; for a long time it continues unduly excitable, responding to the slightest stimulus with disproportionate energy. The memory is defective; often, curiously enough, the accident itself and the events of a few hours before are completely forgotten; the patient is liable to unreasonable outbreaks of temper; headache and slight attacks of giddiness are not uncommon; there is a peculiar susceptibility to the effects of alcohol, and any little mental emotion or anxiety causes an excessive amount of disturbance. Sometimes this condition persists for the rest of life; the patient loses his aptitude for business or work, and is said by his friends never to have been himself again.

### Contusion of the Brain.

This may or may not be attended by concussion, according to the extent of surface that receives the injury and the amount of general shock, and it may either cause a definite train of symptoms of its own, or it may be so confused with concussion, compression, or hyperæmia as to be almost unrecognizable.

Laceration of the brain may occur without any wound of the soft parts or fracture of the bone; probably it is present in all cases of severe injury to the head—certainly if there is a fracture, and it is produced either by the sudden alteration in shape when a violent blow falls upon the skull, or by fragments of bone or foreign bodies that are driven in. In the latter case the dura mater is torn; there may be hemorrhage from the meningeal arteries, and the injury may be compound. The brain is bruised either immediately under the seat of injury,

the opposite side at the other end of the diameter; the sudden arrest of the motion when the head strikes the ground dashes it against the opposite side of the skull, and especially if the surface is uneven or irregular, bruises it there. If the force is at all severe, it is hurt in both places. This contre-coup (as it is called) may occur at any point, but is met with most frequently in the temporo-sphenoidal lobe, or on the under surface of the cerebellum, because of the frequency of falls upon the occiput. Multiple hemorrhages from the rupture of small vessels, deep in the substance of the brain, or on the floor of the fourth ventricle, are often found in post-mortem examinations of these cases, in addition to the superficial injuries. It is possible that these may not present, but, unless they involve some part the function of which is known there is no means of making a diagnosis.

The hemorrhage may vary from a mere superficial bruise, with a few points of extravasation on the surface or in the substance of the gray matter, to complete laceration. When it is severe, the hemorrhage may plow up the cortex in a wedge-shaped manner, deep into the white substance and spreading in the sub-arachnoid space over the greater portion of one hemisphere. It very rarely breaks through the pia, but not unfrequently extends into the subdural space as well as the subarachnoid. The subsequent changes are the same as those that follow all hemorrhages. As soon as the hemorrhage ceases the vessels round the seat of injury dilate, the circulation becomes more rapid, lymph pours out, inflammation of the structures around, so that the pia mater becomes thick and opaque, the neighboring brain substance becomes so soft that it can be scraped away like pulp. Then, if the part injured is not a vital one, if the hemorrhage is sufficient to cause compression, and if there is no further injury by splinters driven in, and no septic decomposition, the hemorrhage ceases, the hæmoglobin soaks into and stains the tissues around, the blood corpuscles are absorbed, the torn and lacerated brain substance undergoes repair, the damaged portions are removed or repaired. The subarachnoid space becomes filled with lymph, which organizes and becomes firmly adherent to the membranes, and discolored from the blood extravasated into the subarachnoid space is usually absorbed. If there is an extensive collection in the subdural it may become encysted, a brownish-colored membrane on the under surface of the dura mater may lose its color completely and gradually become converted into a transparent cyst, generally adherent, either to the dura mater or sometimes quite free, resting in a depression on the brain.

Recovery, however, is not always so fortunate; in many cases the hemorrhage is so great as to cause compression of the brain, and death results in a few hours from coma and paralysis, or the hyperpyrexia may increase until, after the lapse of two or three days, death occurs. Injury may happen even when there is no external wound, as when spiculæ of bone are driven into the dura mater and brain. An injury of this kind is always the result of direct violence, the deeper parts suffer in particular, owing to the wound being of such a shape and depth that it can rarely be cleaned, with broken down blood clot ready to decompose, and with dirt and foreign matter. At a later period, after the primary dangers are long since past, others are sometimes developed. The softening and degeneration of the brain in the vicinity may spread to the parts around, so that large portions of the brain inflammation sets in, and an abscess forms in the brain substance. The cord becomes atrophied from pressure, and sclerosed in the posterior and lateral columns of the cord.

The symptoms of contusion of the brain depend upon the amount of hemorrhage, and in cases they are entirely absorbed; in all cases of

ussion, for example, a certain amount of bruising is present, but unless the ry is extensive, or some special centre is involved (such, for instance, as that h controls the function of speech or the movements of the arm), there is no ence of it. The occipital, temporo-sphenoidal, and part of the frontal lobes be very seriously injured without there being any symptoms of it, though e may be every reason to suspect it.

In other cases symptoms are present similar to those of concussion; at first e is extreme depression, the patient lies almost unconscious in a state of pro- nd shock; then, when this passes off and the circulation through the brain ins to recover, a period of reaction sets in; the temperature rises, the face omes flushed, the patient becomes excited and irritable, and, perhaps, if the eræmia extends to the motor area, spasmodic contractions of groups of muscles, l even general convulsions, occur. But though the symptoms may be of the ne class in concussion and in contusion, there is a striking difference in the gth of time they last. In the former the hyperæmia is transient, and either sides or passes on into inflammation within forty-eight hours; in the latter it y persist for weeks. In the one case there has been temporary paralysis of the lls of the vessels, and, as in a limb when Esmarch's bandage is removed, this is lowed by a transient hyperæmia as soon as the circulation recovers; in the er the brain substance is crushed and torn, and, just as the skin over a severe ise remains hot and tender until the injury is completely repaired, so there y be hyperæmia and increased excitability of the nerve tissue for a variable tance around the bruising in the brain for a proportionate length of time.

Such cases are often met with after severe injuries to the head, as, for example, cture of the base of the skull; and the prognosis is always very grave, for, ugh a large proportion recover, further hemorrhage or inflammation of the n may occur at any time. There are the same symptoms as in the later stages concussion, but they are much more strongly marked. The patient lies curled n bed, with every joint flexed and his head turned away from the light; he is scious, but pays no attention to anything; if spoken to, he does not reply, if roused, or if an attempt is made to move him, he often becomes violent or ive, and tosses himself restlessly from side to side until the old position is ined. The head is hot and aches violently; the face is flushed, the pupils racted, and the temperature generally slightly above normal. In severe cases, patient often passes fæces and urine in the bed; sometimes, but not often, e is retention. Then, gradually, at the end of perhaps three or four weeks, n the circulation through the brain is again becoming normal, the irritability ns to subside, the other symptoms disappear, and often the patient will declare he has absolutely forgotten, not only all that has happened during his illness, the accident itself and the events that immediately preceded it.

In the third class of cases there are local symptoms, either by themselves, or ldition to these. The injury has affected a portion of the brain which is con- ed with carrying out some special work, and the effect depends upon the ee to which the nerve tissue suffers. If it is disorganized, the function of the , whatever it may be, is abolished; later on it may recover, or some other ion of the brain may perform its duties more or less well; but for the time g its action is completely lost. This, when it involves a group of muscles, is wn as *monoplegia*. If, on the other hand, the injury is not so severe, if it is ly sufficient to excite and increase the irritability of the cortex without roying it, there may be spasmodic contraction of groups of muscles (*mono- ms*) or of a limb, or even general convulsions affecting the whole body. The rrence of either of these symptoms is of the greatest significance; if they are l, and if they occur within twelve hours of an injury to the head, they point nitely to some laceration of the brain or to progressing hemorrhage involving cortex of the medulla.

(*a*) *Cortical Lesions.*—The symptoms to which these give rise are always ifested on the opposite side of the body. It must be remembered, however,

that as injury to the brain by *contre-coup* is very common, this may be on the same side as the injury to the head.

A blow upon the right side of the occiput is frequently followed (in right-handed people) by aphasia. This may be accompanied by spasm or by paralysis of the muscles of the lower part of the face on the right side, or either of these may make its appearance later, as the hemorrhage extends. The patient, on coming round from the concussion, is entirely unable to speak, or can only make use of a limited number of words, or constantly uses wrong ones, and is conscious that he does so. The centre for speech is situated in the posterior part of the third left frontal convolution, and immediately behind it, at the lower end of the ascending frontal one, is the centre that controls the movements of the lips and mouth associated with it. In a fall upon the right side of the back part of the head this portion of the brain is dashed violently against the edge of the anterior fossa of the skull. If the bruising is severe there is complete loss of function, if slight, it is only partial, and if the bleeding continues, the effect spreads in order to the neighboring centres, first irritating them and causing monospasms, then compressing or destroying them, so that monoplegia sets in.

Spasmodic contraction or paralysis of the upper part of the face and eyelids, after a severe blow upon the head, is due to injury of centres that lie a little higher up in the ascending frontal convolution. The lower part of the face and the platysma are affected when it extends to the ascending parietal on the same level. Brachial monospasm or monoplegia is the result of irritation or compression of the middle portion of the same two convolutions, the centre for the movements of the arm, like those of the muscles of the face, lying on both sides of the fissure of Rolando. If the stimulus continues to spread upward (as, for instance, in hemorrhage from the middle meningeal) the associated movements of the leg and arm become involved, and if it extends so far backward that it reaches the superior parietal lobule, those confined to the leg alone. The muscles of the trunk appear to be under the control of centres that lie on the inner side of the hemisphere facing the falx cerebri.

1. *Cortical Paralysis.*—If the bruising is severe, this is immediate; if not quite so bad, it comes on gradually, some hours, perhaps, after the accident, and, as the hemorrhage extends, spreads by degrees from one group of muscles to another. Often, especially if there is hemorrhage into the subarachnoid space, the paralysis is preceded by convulsions, which may involve the same muscles, or may be general, or may even affect the opposite side of the body; the blood, as it spreads over the surface of the cortex, stimulates it first, and then compresses it, until, perhaps, the whole of one hemisphere is covered in. As a rule, the paralysis of simple contusion (without compression) stops short of complete hemiplegia. If it makes its first appearance after the lapse of several days, or if it continues to extend, it is a sign either that the softening is spreading, or that there is the commencement of a cerebral abscess.

2. *Cortical Spasm.*—In some cases this is immediate, caused by the irritation of the laceration or by the blood as it spreads over the surface of the brain; in others it does not make its appearance for some time. If the interval is only a few days, it is probably due to the hyperæmia that sets in around the injured area; either the sensitiveness of the cortex increases so that repeated discharges of nerve force take place without any apparent stimulus, or the circle of hyperæmia is spreading and now for the first time involves the motor area; whichever it may be, the prognosis is very grave, for though such injuries may end favorably, inflammation and suppuration sometimes occur, even when there is no fracture. If the first appearance is still further delayed, not perhaps until a month has passed, the suspicion of cerebral abscess at once arises.

The convulsions are always sudden, occurring without any warning; and they may either be purely local, or, especially if they are repeated, they may spread from one centre to another, always extending in a definite and intelligible order until they become general and involve the whole body. The fits may be momen-

ry, or they may last half an hour or more; consciousness is not lost, as a rule, nless they occur in rapid succession or become general; and they may either abside or end in paralysis. If the hemorrhage is extending, each outbreak ay be followed by a further diminution of consciousness and an increase in the rea of loss of power, until at length coma and general paralysis occur together. General convulsions, resembling an epileptic fit, coming on immediately after an injury, may be the result either of powerful stimulation of one part of the cortex only, or of rapidly increasing compression and anæmia. In the latter case they are followed by profound coma.

(*b*) *Medullary Lesions.*—Much less is known with regard to the symptoms and localization of these. Multiple contusions are not uncommon in the white substance of the hemispheres, and if they interrupt the course of the fibres from the cortex, the general effect is the same as if the centres themselves were destroyed; but unless the blood makes it way into one of the lateral ventricles (which as the result of injury is very rare) and sets up compression, the extent of the hemorrhage is never great. In fatal cases of concussion minute points of contusion are usually found, but it seldom happens that there are any very definite signs of their presence during life. Sometimes, however, there are symptoms which point to injury about the floor of the fourth ventricle; there may be persistent vomiting, possibly due to some irritation about the root of the vagus; or the pulse rate may remain abnormally slow, perhaps for the same reason; or there may be disturbances in the region of the vasomotor centre, giving rise to diabetes, polyuria, albuminuria, or hæmaturia.

## Compression.

In its most typical form, apoplexy, for example, compression of the brain presents a striking contrast to concussion; but very often one can scarcely be distinguished from the other, and if, as not unfrequently happens, compression follows concussion before the rallying stage sets in, it may be impossible to say when the addition takes place.

**Causes.**—It may arise from injury, inflammation, or the presence of new owths. Extravasation of blood and inflammation are the most common causes. e former occurs either immediately after an accident, or within a very few hours, d may lie between the dura mater and the bone, in the subdural or subarachid space, in the substance of the brain, or in the cavity of the ventricles. mpression when due to inflammation does not appear until later. If the ain is involved primarily, as sometimes happens after concussion, there may some indication of it within the first three or four days; if it is secondary, sequent on meningitis or acute suppurative osteitis, it rarely occurs for a week more; and when there are no definite signs of it for weeks or months, it is bably the result of chronic abscess in the substance of the brain. Whether pressed bone by itself can ever give rise to general compression is very doubtful; en there is a tumor it is often present toward the end, especially if it is a pidly growing one, or if there are hemorrhages in connection with it.

The effect of pressure upon the nerve centres depends to a great extent on e rapidity with which it acts. If it is sudden, convulsions and even an epileptic may occur before the function of the cortex is abolished; but this is more mmon in animals than in man. If it takes place slowly, the brain accomdates itself to the change so far as it can. In some cases as much as eight nces of blood has been found, but probably the amount necessary to produce al compression varies very much in different individuals. The cerebrospinal id first makes way by flowing down the spinal sheath; then the smaller vessels the brain become compressed; the stream becomes slower and slower, until it ps altogether. At first the effect is local, and limited to the region of the se; but gradually it spreads to other parts that are to some extent protected the falx and the tentorium; finally, the base of the brain becomes bloodless, nvulsions perhaps set in, and life becomes extinct. Unless there is hemorrhage

into one of the lateral ventricles, compression is nearly always gradual, and leads steadily from impairment of function to complete loss, the higher centres suffering first; but in inflammation or abscess of the brain, the last stages may be relatively very rapid. The chief difficulty arises from the fact that compression is seldom met with unmixed; nearly always it is associated with concussion, contusion, or hyperæmia, not unfrequently with all three at the same time.

**Symptoms.**—(*a*) When the compression is general they are very much the same, whatever the cause may be. The patient lies in a state of complete coma; voluntary movement and reflex excitability are both abolished; the limbs lie absolutely helpless, just as they are placed, and nothing that is said or done produces the least effect. The surface of the body may be cool, or bathed in perspiration; in some cases extreme high temperature has been noted. The breathing is slow and labored, often stertorous from paralysis of the soft palate, and accompanied by a peculiar puffing in and out of the cheeks; the pulse is full and strong; the vasomotor and the cardiac centres in the medulla are both affected; the pupils are fixed and generally dilated, or one of them is dilated (generally the one on the side of the compression) and the other contracted; the urine is retained until the bladder becomes full, and the fæces are passed involuntarily. Convulsions are very rarely present unless the compression takes place suddenly, and then they are soon followed by coma and complete paralysis.

(*b*) In local compression, on the other hand, the symptoms depend upon the nature and position of the exciting cause, and consciousness is not lost. If the pons or medulla is involved, the effect, as may be imagined, is of the most serious character, threatening life from interference either with the nerve centres themselves, or with the trunks on their way through the skull. The anterior part of the brain, on the other hand, may be almost destroyed without any definite local evidence, unless the third left frontal convolution is involved at its posterior extremity. Pressure upon the motor area of the cortex is the best defined, causing paralysis of the opposite side of the body, either of certain movements only, or of one limb, or of the whole side, according to the extent of the injury.* When the sensory zone is affected there is rarely any local evidence, although, as MacEwen has shown, a depressed spiculum from the inner table, driven into the anterior portion of the angular gyrus on the left side, may cause typical mind-blindness. In addition to these symptoms, which are directly dependent on the brain, there may be pain from the stretching to which the dura mater is subjected; or there may be evidence of pressure upon the nerves inside the cranium, choked disc, facial paralysis, or neuralgia corresponding to the fifth, or even the blood-vessels may afford some indication—the cavernous sinus, for example, may be compressed so that the eyeball is protruded and the veins of the orbit distended.

**Diagnosis.**—No absolute distinction can be drawn between *concussion* and compression. It is true the former is immediate, while the latter, as a rule, comes on gradually, and that loss of consciousness is rarely complete in the one, while coma is a symptom of the other; but when there is a condition of profound shock, such as often occurs after severe head injuries, it may be impossible to make an exact diagnosis, especially as one is not seldom only a prelude to the other. The same may be said of *contusion*. The effect on a centre in the cortex is much the same, whether it is crushed by an extravasation between the dura mater and the bone, or by one in its own substance; only in contusion monoplegia is either immediate or is preceded by monospasm, and extensive paralysis, especially hemiplegia, is uncommon; while in compression, pure and simple, there is usually

* In one case under my care, in which the whole of the left side of the body was paralyzed, more or less, consequent on a severe blow immediately in front of and above the right parietal eminence, there was a decided fall of temperature on the affected side. The patient was a child six years old; concussion was well marked, but passed off; symptoms of local compression followed and became more and more intense for forty-eight hours, affecting the face and tongue (very slightly), the arm (almost completely), and the leg. Twenty-four hours later the loss of power began gradually to disappear.

terval of a few minutes, or even of some hours, and the paralysis, if the symptoms re not masked by concussion, commences imperceptibly. Convulsions only ccur in compression when it is rapid, and this rarely happens, for hemorrhage nto the lateral ventricles is not common as the result of injury; depression of one is hardly ever sufficient, and bleeding on the surface or in the substance of he brain is nearly always gradual.

*Alcoholic coma*, especially that which is induced by rapid spirit poisoning, is sometimes mistaken for compression, particularly if there is an injury to the head at the same time; more often the converse happens. There is nothing in the temperature, or the pulse, or the respiration, that can be relied upon. MacEwen, however, has shown that in alcoholic coma the pupils, which are contracted to a pin's point, very slowly dilate when an attempt is made to rouse the patient, and then, if he is left undisturbed, gradually begin to contract again, until in ten or twenty minutes they have resumed their former size. If there is any doubt the urine should be drawn off and examined for alcohol, which is often present in large quantities in these cases; but it must always be remembered that the two conditions may very easily occur together.

*Opium coma*, in the absence of history, is sometimes a little difficult to distinguish, though the diagnosis may be suspected from the peculiar character of the pulse and respiration and the fixed contracted condition of the pupils, unless they have become dilated again, and they do toward the end. In the case of laudanum the odor or the stomach-pump may make the question certain; but this fails completely with morphia, especially if it is injected subcutaneously. In *uræmia* the coma is not so continuous, there are epileptiform convulsions, the breathing is quiet, not stertorous, and there is no paralysis.

When compression occurs immediately after an accident, without any interval, can only be the result either of very extensive depression of bone, or of extravasion of blood, either into the cavity of the lateral ventricles or at the base of the brain. If it is more gradual, if it does not make its appearance for some minutes, or even for some hours, the extravasation is either between the bone and the dura mater, in the subdural space, or in the substance of the brain. Of these the former cannot be distinguished from each other; the last may be suspected if there are signs of cerebral irritation in addition to those of compression, or if the patient does not regain consciousness after the accident.

Compression following inflammation of the meninges is always general; that due to cerebral abscess or tumor may be local at first; in either case the diagnosis must be based upon the previous symptoms.

## Wounds of the Brain.

Incised, punctured, and contused wounds of the dura mater and the brain are not uncommonly met with in conjunction with fracture of the skull. They may be produced by cutting instruments, such as knives and sabres, penetrating the bones, or even slicing off a portion of the skull and the brain beneath it; or by blunt weapons, such as sticks or slate-pencils, driven through either the roof of the orbit or the cribriform plate of the ethmoid, often without any apparent external injury; more often still by fragments of bone driven inward; or as a result of gunshot injuries. These last are, generally speaking, fatal at once; but instances in which small revolver bullets have entered the skull and have remained lodged in the substance of the brain for years are not uncommon.

The cortex is the part that is usually affected; the base rarely suffers except in gunshot injuries through the mouth; and the immediate symptoms depend upon the extent and locality of the injury. As a rule there is no difficulty in the diagnosis, but in some cases of depressed and punctured fractures the rent in the dura mater may lie concealed beneath an overhanging margin of bone, and be overlooked if this is not elevated. The prognosis is always grave, even when the injury is so slight that there is no immediate risk to life; foreign substances are

often carried inward—bullets, fragments of bone, hair, even portions of a hat; the wound is exceedingly difficult to clean thoroughly: in many cases—as, for example, gunshot injuries—no attempt can be made; it is, generally speaking, more or less valvular, that is to say, there is a small opening in a tough, unyielding membrane leading into a space filled with broken down brain substance and extravasated blood, and inflammation of the membranes or of the brain and hernia cerebri are proportionately likely to occur.

### Intracranial Hemorrhage.

This may take place, as already mentioned, between the dura mater and the bone; in the subdural or the subarachnoid space; in the substance of the brain itself; or in the cavity of the ventricles; and it may occur rapidly when there is a large space for it to collect in or when a large vessel is torn across; more often it takes place slowly and continues until either the tension and the coagulation are sufficient to close the vessels or fatal compression is induced.

1. Hemorrhage between the dura mater and the bone may occur from injury to one of the venous sinuses, but it is rarely of any surgical importance unless it is caused by rupture of the middle meningeal artery or its anterior branch; then it gives rise to a series of symptoms which may be taken as the type of those of compression.

It may be produced either by direct violence or by a fissure extending from the vertex; sometimes the force of the blow is exceedingly slight, and there is no concussion, or only a transient sense of giddiness; and it is said to have occurred without fracture of any kind being detected. Generally speaking, the extravasation takes place on the same side as the injury; but the opposite artery may be torn if the fissure extends across the base of the skull, and possibly in fracture by *contre-coup*. In a characteristic case the patient is stunned for a time and gradually regains consciousness. Then after an interval sometimes of half an hour, sometimes of a day, symptoms of compression begin to set in. The patient becomes drowsy; the muscles on the opposite side of the body begin to lose power, those of the face perhaps first, then those of the neck and arm, and finally the leg and trunk; the pulse becomes slow and full; the drowsiness deepens into coma; the respiration becomes stertorous and the compression complete. Convulsions are not generally present, though I have known them to be brought on, in a case of comminuted fracture associated with only meningeal hemorrhage, by pressure with the finger over the seat of injury. The eyeball on the injured side is sometimes protruded, probably from pressure upon the cavernous sinus, causing congestion of the orbit; and, what is of very great significance, the pupil on the same side (opposite to the hemiplegia) is dilated. It is said that this is due to pressure upon the trunk of the third nerve, and that it may be preceded by a transient contraction, pressure when it is slight first acting as a stimulus, and then as it increases destroying the conducting power; but it may certainly occur when the extravasation is nowhere near the course of the nerve. The diagnosis can only be certain when there is a distinct interval after the concussion, and when the compression begins locally and spreads gradually without there being any evidence of cerebral contusion or irritation. If the latter is present the subcranial hemorrhage is probably associated with cortical or subarachnoid, or these may be present alone.

Subcranial extravasation, due to rupture of the middle meningeal artery, forms a black granular clot of peculiar solidity and hardness between the dura mater and the bone. It is usually disc-shaped, three and even four inches across, thickest at the centre, sometimes as much as an inch, and thinning off toward the margin. There is a cup-shaped depression to correspond on the surface of the brain, and all the convulsions are flattened down. If not so large as to cause fatal compression, the coagulum may become absorbed, but only after a long time.

2. Subdural hemorrhage is rarely met with by itself and cannot be distinguished from other forms. Nearly always it is secondary to cortical and subarachnoid

d extravasation, and adds the element of gradually spreading compression to other symptoms. The blood comes either from the vessels of the pia mater or tex, the arachnoid being torn across, or from the large veins on the upper sur- e of the brain, which sometimes give y just where they enter the superior gitudinal sinus. More rarely the dura ter is wounded, and the bleeding pro- eds from the meningeal arteries or the nous sinuses. When it occurs by itself, e blood gradually extends over the sur- ce of the hemisphere and does not re- ain localized or become hard and dense, in the subcranial form. The vessels are naller and the tension of the extravasa- ion not so great. The symptoms are the ame as those of subcranial hemorrhage, nd, like them, come on slowly and gradu- lly, but they are more vague, the com- ression is incomplete; there is stupor, asting perhaps for days or even weeks, ut not necessarily coma; there may be oss of power over certain muscles, or ven over one side of the body, but there s no well-defined paralysis. If the patient urvives, cerebral hyperæmia and irri- ation are almost sure to set in; head- che, irritability, spasmodic contraction of he muscles, even general convulsions may ccur; and there is always a certain egree of fever and some risk of inflammation. Recovery in these cases is always ry slow and often remains imperfect; the blood may be absorbed completely, t it often forms a false membrane adherent to the dura mater or arachnoid, at t soft and vascular, later becoming tough and hard; or it becomes organized o a cyst, which at length loses its color completely, becoming transparent, and ts free in the arachnoid space. Memory often remains defective; or the patient omes liable to violent outbreaks of passion, or there may be complete loss of control; and even insanity and epilepsy have been known to declare them- es at length.

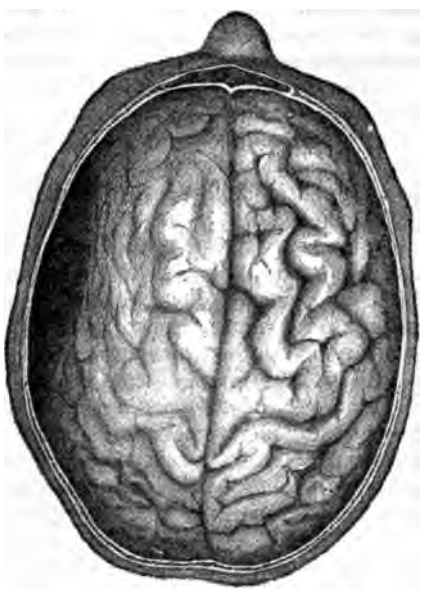


FIG. 288.—Hemorrhage from the Middle Meningeal Artery.

3. Subarachnoid hemorrhage is practically always associated with severe in- to the cortex, and is secondary to it; often it extends into the subdural space well. The blood, if the arachnoid does not give way, pours down into the ci and over the convolutions, until it may reach the big subarachnoid space at base of the brain. There are no symptoms which are peculiar to it; if, how- r, after an accident there is evidence of severe contusion to one part of the in, and if the symptoms, local at first, rapidly become general, involving one tre after another in quick succession, causing first convulsions and then alysis, it may be conjectured that extravasation into the subarachnoid space is t at least of the injury present.

4. Cerebral hemorrhage when slight rarely admits of diagnosis. There is le doubt that minute extravasations are present in all cases of concussion, but, rule, they give rise to no special symptoms. When they are extensive— en, for example, a diseased artery gives way under a sudden shock and the ex- asation bursts into one of the ventricles, causing an apoplectic fit—the symp- ms are altogether general; there is no local indication of any kind.

origin.

The optic is frequently affected. If the
in the corresponding half of the field of visio
the chiasma itself, either the inner or the out
cording to the position of the lesion. The t
at the optic foramen, or crushed by a splinte
and complete blindness; or hemorrhage may
compression of the nerves and choked disc
meningitis or cerebral abscess occurs, double

Paralysis of the third nerve gives rise to
the position of external strabismus, dilation
accommodation. Sometimes the eyeball app
injury is in the crus there is coincident hemip
of the fourth merely affects the superior obliq
ing downward; giddiness, when going down
The sixth, which supplies the external rectus
any other of the orbital nerves. Injury to th
plete anæsthesia of that side of the face, may
the mouth; but the lesion generally proves fa
sory divisions are affected after their separati
from irritation of the fibres or complete anæs
on that side of the face becomes cold and pu
bility and becomes inflamed; the lachrymal
and there is complete loss of smell and taste
mucous membrane. The anæsthesia and trop
the injury is peripheral than when the origin
from injury to the motor portion is rare, but
character of the movements of the lower jaw.

The facial, which is frequently involved
of the skull, may be injured at its origin, in
the aqueduct. In the first case the sixth usua
plegia of the opposite side of the body; in th
torn or compressed at the same time, so that
aqueduct the paralysis is limited to the muscl
nerves are injured, to those of the soft palate.
may occur in paralysis of the fifth, the glosso-
hypoglossal. Loss of the sense of taste is
tympani is injured. If the nerve is only com

### *General Treatment of Injuries of the Brain.*

Injuries of the brain may either prove fatal at once, from the extent or the situation of the laceration, or death may ensue in the course of a few hours or days, from shock, inflammation, or compression; or at a much later period secondary complications may set in—softening, cerebral abscess, or epilepsy—and lead at length to the same result. No injury of the brain, no matter how trivial it appears to be, even if it is only attended by a transient giddiness, should be neglected.

*Concussion.*—The collapse of the first stage of concussion may be merely momentary, or may last for hours. In exceptional cases it may terminate fatally, either at once or after a couple of days, without the patient ever having rallied. The state of the pulse, therefore, requires to be very carefully watched. In most instances stimulants are not only unnecessary, but absolutely injurious: the danger is that the symptoms of reaction and the hyperæmia that attends it may run on to inflammation, or that the bleeding may continue, and undoubtedly they would encourage this; but every now and then cases are met with in which they seem indispensable; the heart will fail without; and it must not be forgotten that the mere prolongation of the period of collapse is in itself a source of danger, and tends to aggravate the intensity of the reaction when it once begins.

The patient should be placed in bed with the head low, wrapped up in warm blankets, and surrounded with hot-water bottles; then, as soon as he can swallow, a small quantity of hot tea or coffee may be given. In the vast majority of cases the collapse passes off of itself without anything further being required; if the condition of the pulse becomes alarming, some good may result from the rectal injection of hot water, or the hypodermic injection of atropin ($\frac{1}{100}$ grain); if it distinctly begins to fail, ether or ammonia must be given at once; and if these do not succeed, brandy must be injected subcutaneously. Cases of this kind, however, in which the collapse is so intense, are fortunately very rare.

As soon as reaction commences every effort must be made to keep the hyperæmia within bounds. The room must be darkened, all noise prevented, conversation absolutely forbidden, and complete rest in the recumbent position insisted on. In severe cases the head should be shaved, Leiter's coils applied, and if there is much aching, or if the temperature rises more than a degree, leeches should be placed behind the ears. Milk and beef-tea only should be allowed, and in small quantities; and the bowels should be opened as soon as possible, either with five grains of calomel or with a minim of croton oil. The former may have some influence on inflammatory exudation, but in addition it is no slight advantage that it may be placed upon the tongue of a person who is insensible with perfect safety, and that there is little risk of its being vomited. If this does not succeed, if the temperature continues to rise, and particularly if the head begins to throb and heat, there should be no hesitation in making use of venesection, and withdrawing six or even ten ounces of blood. Whatever may be the way in which this acts, there is no doubt that it sometimes stops incipient delirium at once.

[Fluid extract of ergot has extreme value in reducing cerebral hyperæmia, and it will be found useful in all varieties of cerebral injuries where hyperæmia is manifested by the symptoms. A teaspoonful to a dessertspoonful will be required, to be repeated according to the urgency of the case.]

In the case of children with slight concussion it is very difficult to keep them in bed more than two or three days; in more severe cases, especially adults, and where, from the continuance of the symptoms, it is morally certain that there has been some considerable contusion of the brain, and that it has been followed, as contusions are in every part of the body, by hyperæmia and exudation, rest in bed must be insisted upon, until every sign of the mischief has disappeared. This rarely happens under a fortnight, in many cases not for three or four weeks; and until then no precaution must be relaxed.

*Compression.*—The treatment of compression of the brain depends upon what

can be found out from the history and the symptoms with regard to the locality and nature of the cause.

1. Where it is either general from the first, or where there is no definite evidence of local origin, surgical interference is out of the question. If it is recent, within a few hours of an accident, and therefore probably due to hemorrhage, means must be taken to render the return of venous blood from the head as easy as possible by position, and possibly by venesection (though this is not of such service here as it is in controlling the commencement of inflammation), to favor the absorption of cerebro-spinal fluid by free purgation, and to diminish the amount of blood going to the head as much as possible by the application of cold. If some days have passed since the accident, and symptoms of inflammation are already present, the same remedies may be employed, with, in addition, the free use of mercury, but with very little hope. The compression in either case is only a late symptom of an injury over which we have at present little or no control.

2. Where, on the other hand, the signs point to some local cause, and where the nature of the case is such (as it nearly always is when the compression is the result of accident) that there is but slight prospect of spontaneous improvement, means must be taken as soon as possible to relieve the brain.

(*a*) If the symptoms are immediate they may be due to depression of bone. Mayo Robson has recorded a case in which brachial monospasm and monoplegia were caused by this, and relieved almost at once by trephining, ten days after the accident. The dura mater was intact and there was no evidence of subdural hemorrhage or of cortical bruising. Whenever anything of this kind can be ascertained, the depression must be elevated, and the sooner the better; the longer the case is left the greater the risk of inflammation breaking out, or of a discharging lesion being set up in the cortex, so that, after the original cause has been removed, epileptiform convulsions continue.

(*b*) If the symptoms do not set in at once, if there is a distinct interval of partial or complete return of consciousness, without any evidence of cerebral irritation, there is probably subcranial hemorrhage, with, exceptionally, subdural in addition. It may come from the anterior division or the trunk of the middle meningeal; more rarely from its posterior division or the lateral sinus; very rarely from any other vessels.

Hemorrhage from the middle meningeal is not necessarily fatal, from the anterior division at any rate; but it is so in the great majority of instances, and consequently, if the diagnosis is clear and the symptoms show that the extravasation is extending, an attempt should be made to check it either by ligature of the external carotid artery, or by trephining. The former operation has not been tried sufficiently often to justify its recommendation; the latter may be carried out without much difficulty, so long as the case is recent. If there is an external wound this should be made use of; if there is not, the artery may be found midway between the auditory meatus and the external angular process of the frontal bone, an inch or an inch and a half above the level of the zygoma. A triangular flap, comprising the skin, the temporal aponeurosis, the muscle, and the periosteum is reflected downward from off the bone, and the surface of the greater wing of the sphenoid and the inferior angle of the parietal examined. If there is a fissure, the point of the trephine is applied over the spot where the fracture and the line of the vessel intersect each other. As soon the circle is removed a dense, almost black, coagulum presents itself in the opening. This has to be literally scraped out, and often it is necessary to enlarge the opening in one or other direction by means of Hoffmann's forceps in order that this may be done effectually. A greater difficulty is to secure the bleeding point. The artery is superficial only where it occupies the canal in the parietal bone; for the rest of its course it lies in the dura mater, and this, with the brain, is pushed away from the skull by the coagulum. In recent cases the brain may rise up again as soon as the clot is removed, but this is not invariable, especially if the injury is of some days' stand-

ing: or the trephine opening may not have exposed the wound in the vessel; or the cavity fills up again with blood as fast as it is emptied, so that the bleeding spot cannot be seen. Ice-cold water, and pressure upon the carotid, are usually sufficient to check the hemorrhage for the time; but if the bleeding point is not exposed, it is better to enlarge the trephine opening until it can be found and ligatured. If this is not done, the bleeding is very likely to return as soon as the parts are restored to their position and the normal temperature is regained. Afterward the wound must be well washed out with corrosive sublimate or some other antiseptic, the whole of the clot removed, and free drainage provided for from the posterior extremity. If the cavity is a large one, it is advisable to make a second opening in the bone.

If instead of the clot presenting in the wound the dura mater is dark purple in color, and is forced up into the opening without the normal pulsation being perceptible, it is probable there is subdural hemorrhage. This, if the pressure symptoms are so severe as to threaten life, must be treated in the same way as subcranial; the opening in the bone must be enlarged to a sufficient extent, the dura mater incised and reflected in a flap so arranged as not to injure its own vessels, the clot washed away, or, if the arachnoid is injured, carefully picked off, and then the membrane, the bone so far as possible, the pericranium and the skin, carefully replaced and sutured to their corresponding parts, one by one, an opening for a drainage-tube being left at the spot that is most dependent when the patient is lying down.

Even when there are symptoms of cerebral irritation and laceration in addition to those of compression, the treatment must be conducted on the same principles so long as there is evidence that the injury is local. If it is general, nothing can be done; but if local convulsions occur, and if they spread and involve other groups of muscles in definite order, and particularly if every convulsive fit is followed by an increase in the area of paralysis and a further diminution of consciousness, so that it is almost certain, not only that there is an extravasation of blood involving a particular portion of the cortex of the brain, but that it is spreading and that it will inevitably result in fatal compression, the question arises whether it is not advisable to trephine and explore. Cold, bleeding, first local and then general, profuse purging with calomel, or, if there is no time for that to act, with croton oil, and internal remedies that assist in causing hæmostasis, may be tried; but if the symptoms persist, and particularly if the compression is extending, there can be little doubt as to the ultimate result if the case is left to itself. Everything depends upon an exact diagnosis of the locality; and, of course, this is only practicable when certain portions of the brain are involved, and when there has been an interval of at least partial consciousness since the accident. The history is of the utmost importance; the condition of the scalp and skull must be thoroughly examined, as well on the sound side as on the injured one, and the closest attention must be paid to the course the symptoms take. In such a case, where everything points to an injury that is local at first, and where the prognosis admits of little doubt, the scalp should be reflected, bringing the pericranium with it; a large opening should be made with the trephine, unless, as probably happens, the bone is already comminuted, and if the dura mater bulges into the wound or appears purple in color from the extravasation beneath, or if when it is touched spasmodic contractions make their appearance in any of the muscles, it must be reflected as well, the clot turned out from beneath, and the seat of hemorrhage exposed. Such cases must always be rare, for unless consciousness returns, for a time at least, it is scarcely possible to prove that one portion of the cortex has been involved; and it is absolutely beyond our power to show that there are no deeper lesions.

### Traumatic Epilepsy.

Injuries of the head are occasionally followed by epilepsy. Generally it does not make its appearance for some time after the accident; and at first the fits are slight and infrequent, not attended by loss of consciousness; but as time passes the frequency and intensity increase, until at length they end in permanent impairment.

The severity of the accident does not appear to have anything to do with it; and in many cases the immediate cause seems rather to be an injury to the coverings of the brain than to the brain itself. In some cases the cicatrix on the scalp is tender and sensitive, with a constant sense of burning; pressure on it may cause a fit; or an aura may start from it. In others some injury to the bone seems to be the exciting cause; it may be thickened or hardened; or there may be irregular nodules on its inner surface; or there may have been inflammation, leaving a sequestrum. In others again the stimulus proceeds from some affection of the membranes; the dura mater has been found thickened and yellow; sometimes it is adherent to the cortex; or it has undergone calcareous degeneration; or there is a cyst, possibly developed from a blood-clot, upon its inner surface.

In another class no lesion can be found in any of the structures that cover in the brain. The exciting cause is in the cortex itself; and if the affected part lies in the motor area, if the spasm always starts in certain muscles, or extends in a certain order, the exact spot may be defined without reference to the injury. There may be no gross lesion perceptible in the brain; but that the disease is dependent upon some alteration in this particular part is clear from the fact that excision of it is followed by complete and, in some cases at least, permanent cessation of the fits.

**Treatment.**—If it can be shown that the convulsions are excited by a local irritation anywhere, the part should be excised without delay. In the case of injury the superficial scar should be removed altogether, the bone beneath carefully examined, and, if there is the least suspicion of any alteration, trephined. Where it is thickened or otherwise affected, and where the dura mater appears healthy beneath, this may suffice; but if the membrane is marked with scar tissue, or if it is yellow, or if it is fixed down to the cortex, it should be cut away from under the trephine opening and the adherent portion of brain removed with it. It is true that when the motor area of the cortex is excised loss of power in the corresponding muscles follows; but as a rule this is only temporary, and even if it were permanent the cost would be slight. Hughlings Jackson and Ferrier have shown, in non-traumatic cases, that the removal of an epileptogenous focus in the cortex of the brain (if it can be localized) is not only justifiable, but called for, whether any gross lesion, such as scar tissue or tumor, can be found or not; and when there is in addition the evidence of injury to assist in the diagnosis of the situation, there should be no hesitation. One or two convulsive spasms not unfrequently occur after the operation, but in many cases the improvement has not only been marked, but has persisted.

This operation must be clearly distinguished from that performed by Arcilza, who, in a case of true epilepsy, commencing with convulsive movements of the left arm, extirpated the whole of the brachial motor area on the right side. Paralysis followed, and as this passed off the convulsions returned as badly as ever.

### Traumatic Insanity.

This does not occur so frequently as epilepsy, but there are several cases recorded in which it has followed injuries of the head. Byrd has reported four in which the operation of trephining was performed: one died, one improved for a time, and two are stated to have entirely recovered.

## SECTION III.—DISEASES AND INJURIES OF THE HEAD.

### SURGICAL DISEASES OF THE SCALP.

#### Erysipelas.

This is frequently met with as a complication of wounds; even in the so-alled idiopathic cases it is probable that there is some scratch or abrasion through which the pathogenic germ gains entrance]. It does not differ in any ssential respect from the same affection in other parts of the body, but, owing o the anatomical structure of the scalp, the local signs, the swelling and redness, re generally ill-defined, while the constitutional ones, especially those which, ike the headache, wandering, and drowsiness, may be referred to the disorder in he subjacent structures, are unusually prominent. The prognosis is always grave, wing to the possibility of cerebral complications.

#### Suppuration.

This may be either diffuse or circumscribed. The former is exceedingly grave, wing to the rapidity with which it spreads through the loose subaponeurotic layer. The inflammatory products, unable to escape, make their way in all directions nder the tendon of the occipito-frontalis, spreading down into the eyebrows in ront, to the superior curved line of the occipital bone behind, and as low as the ygoma at the sides. The whole surface of the head becomes swollen and puffy. The skin is hot and exceedingly painful; at first, owing to the dense aponeurosis etween it and the seat of inflammation, it is white and tense; later, if left, it ecomes soft and boggy; red patches form in the temporal and mastoid regions, nd, finally, it gives way, allowing the escape of an immense amount of pus, mixed ith shreds and sloughs. The constitutional symptoms are most severe: the head-he is intense, the temperature many degrees above normal, and wandering and lirium are rarely absent. If left to itself, the whole of the cellular tissue beneath aponeurosis may gradually come away, and after a prolonged illness, the oppos-surfaces may grow together, or the skin and the pericranium may slough, leaving ge districts of the cranial bones deprived of their blood supply, or the inflam-tion may spread along the emissary veins into the diploë, causing osteophlebitis, meningitis, thrombosis of the sinuses, and pyæmia may follow.

The cause is nearly always the sealing up of an imperfectly cleansed wound. ere is no harm in sutures if the injured surface is thoroughly washed out and a phole left at the most dependent angle for drainage; but at the first sign, if re is any rise of temperature, or the least tenderness by the side of the wound, e or two of the stitches should be cut, and the edges gently separated with a obe. Probably a small bead of pus will escape, and all will be well. If this ge is past and the inflammation is already diffuse, the whole wound should be pened, incisions parallel to the main vessels made wherever there is the least sation of bogginess, and warm boracic fomentations applied to encourage the charge. If the vitality of the tissues is not already broken down, they will gin at once to throw off the poison and protect themselves with a layer of vascular nulations. Convalescence, however, is always very protracted; drainage uires careful watching; the scalp itself may need to be fixed by strapping; the ughs often take a long time separating; and, as a rule, the patient's constitu-n is not of the best.

Circumscribed suppuration may occur in the skin and subcutaneous tissue; per, in the subaponeurotic layer, or between the pericranium and the bone.

and crystals of cholesterin, often of a peculiarly offensive odor. This is ly likely to occur if they are injured or if they become inflamed; and then rior begins to throw out granulations and forms a fungating vascular mass, in appearance, closely resembles epithelioma, and possibly may in some ss into it.

ese cysts should always be removed before they become inflamed. The : way is to make a linear incision through the skin over them, down to, but ) the cyst wall, and then quickly isolate them by separating the soft cellular n either side with the handle of the scalpel. The larger ones, however, se which have been inflamed must be transfixed, emptied by squeezing, and ssected out, the edge of the wall, where it has been divided, being firmly with a pair of forceps. In no case may any portion of the cyst be left or union will not take place.

*rny excrescences* are occasionally produced from sebaceous cysts that have d or been opened. The sebaceous material on the outside dries up and into a kind of horny layer, while a fresh production is continually going ıe base. In some cases they attain a length of several inches.

ıher varieties of tumor are rare in comparison. *Cirsoid aneurysm* may circumscribed *fibroma* is occasionally found, and there are a few instances ırd of an enormous diffuse growth of fibrous tissue, forming great pendulous (*pachydermatocele*). Probably it is akin to elephantiasis, and may be con-

*Epithelioma* and *rodent ulcer* are sometimes met with, but *sarcoma*, with eption of those forms which originate in the bone or dura mater beneath rolve the scalp secondarily, is very uncommon.

## DISEASES OF THE BONES OF THE SKULL.

### Hypertrophy.

ı osteitis deformans the vault of the cranium is usually immensely thickened. ner surface becomes irregular and is marked all over by arborescent grooves; er remains smooth and even; the diploë disappears, and on section the bone and dense, like ivory. Beyond a gradual increase in the circumference of ıd, it does not appear to give rise to any symptoms; and no treatment is of ıil. Other forms of enlargement are described under Diseases of the Bones.

### Rickets.

peculiar form of atrophy of the inner table, known as *craniotabes*, is occa- ' met with in infants suffering from rickets. It affects especially the poste- erior angles of the parietal bones and the tabular part of the occipital, ly because of the recumbent position of the child, for a certain flattening of rt of the head is not unfrequently noticed at the same time, and in one or tances, in which the disease existed before birth, a similar change has been ın the inner surface of the vertex. The sulci for the cerebral convolutions sually plain, and here and there are marked in their course by little conical ıich, in some places, are so deep that nothing but a parchment-like layer of ater and pericranium is left; the whole thickness of the bone is absorbed. mes in addition there is a granular deposit of new bone under the pericra- n the outer surface, and occasionally a very considerable amount round the ılles and along the sutures, sufficiently to be felt plainly through the scalp. all probability it is due to the effect of continued pressure acting on soft- ıyper-vascular bone. It certainly may occur independently of hereditary s, although it is often associated with it (*e. g.*, Parrot's nodes), and a few es are recorded in which other evidence of rickets was unusually slight.

he diagnosis can only be made in well-marked cases by the peculiar parch- ike yielding on pressure with the fingers. No special treatment is required.

### Inflammation.

Inflammation of the bones of the cranium may be caused by mechanical injury, by the products of septic decomposition, and pyogenic micrococci; and by syphilis, tubercle, and occasionally other specific diseases.

(*a*) Simple inflammation (*rarefying osteitis*) may result from mechanical injury, if it is sufficiently persistent in its action, but naturally such conditions are rare in connection with the cranium. It may, however, occasionally be seen when a portion of bone which has been killed by external violence is quietly removed and detached without suppuration. The tissues around become soft, vascular, and filled with lymph; the bone immediately adjacent to the portion that is dead is absorbed and replaced by a layer of granulations, and at length the sequestrum is loosened, and, as soon as the condition of the scalp will allow it, thrown off. Suppuration is usually present in these cases, but it is an addition and not in any way essential.

The portions of bone that are reimplanted after trephining sometimes behave in the same way. In many instances they contract adhesions to the structures around; in some they appear to become welded together by masses of new bone, although this is not quite certain; but in others they cause a certain degree of irritation; vascular granulation tissue is formed around them; if the constitution is sound and the tissues healthy, they are absorbed; if, on the other hand, the irritation is too great for the tissues to bear, pyogenic micrococci find their way in and cause suppuration, exactly as they do round buried sutures and old sequestra.

(*b*) *Suppurative osteitis* is rarely met with except in compound fractures and the later stages of tubercular or syphilitic caries, after pyogenic organisms have gained entrance as well as specific ones. Exceptionally it may follow a simple contusion, the pyogenic germs being carried to the injured spot by the blood stream (as in Pott's puffy tumor), singly, or, as in pyæmia, in the form of emboli. In any case, there is very grave risk of extension to the meninges on the one hand and the emissary veins and venous sinuses on the other.

(*c*) *Tubercular caries* of the vault of the skull is rare, even in childhood, and is seldom recognized until the skin has given way and left a tuberculous ulcer, the floor of which is formed of softened carious bone.

(*d*) *Syphilitic osteitis* is exceedingly common in all stages of the disease.

Intensely painful periosteal nodes are often present during the secondary period. There is very little swelling, but the most extreme tenderness, so that the patient will not allow a finger to come near. Possibly the severe local headache that occurs sometimes about the same period may be due to a similar affection of the dura mater.

Gummatous deposits, leading to caries and necrosis, are even more common in the tertiary and late hereditary stages. There may be merely a soft and tender swelling on the scalp, or an ulcer with a base of carious bone and undermined overhanging edges; or half the frontal bone may be bare, black, and dead, even through its whole thickness, while the skin around is thickened and curled inward, as if it had shrunk away from the centre as soon as the tension on it had yielded. Immense portions of bone may be lost in this way, and it may be years before the sequestra separate. No new bone is ever formed, and deep radiating cicatrices, through which sometimes the pulsation of the brain can be felt, are left, causing the most hideous and characteristic deformity.

In other cases, corresponding to the diffuse gummatous infiltration of other organs, the diploë becomes completely obliterated, so that the bone on section is solid throughout and exceedingly dense and hard; and occasionally, in addition, great bosses are developed from the inner surface, especially over the frontal region, so that the grooves for the sinuses and meningeal arteries become deep channels.

*Parrot's nodes*, periosteal thickenings of soft vascular new bone, arranged in lamellæ, are characteristic of the hereditary form. They occur round the anterior

tanelle, one on each parietal bone, and one on each half of the frontal, seldom ading the normal centres of ossification, and leave a cruciform sulcus in between, : so-called natiform skull. Occasionally this is associated with wasting or gela- iform degeneration affecting the posterior portion of the skull, but distinguished m craniotabes by its occurring the outer surface. For a ther description see *Syphilitic iseases of Bone.*

FIG. 290.—Syphilitic Necrosis of the Frontal Bone.

**Treatment.**—The constitional treatment varies naturally according to the cause. The cal is much more simple. Free dit must be given to all disharges; sequestra removed as oon as they are loose; and decomposition prevented by proper rainage and antiseptics. Tuercular caries can sometimes be reatly benefited by free scraping nd the application of iodoform. Sometimes exfoliation may be assisted by the se of strong sulphuric acid; and occasionally trephining is necessary, either to lrain an extra-dural collection of pus, or to release a fragment that is locked in, owing to its peculiar shape.

## TUMORS OF THE CRANIUM.

Osteomata and sarcomata are the most common. Carcinoma only occurs as secondary deposit by extension. Hydatid cysts and angeiomata have occasionlly been described.

*Osteomata.*—Those growing from the outer table are sometimes called xostoses; those from the inner and diploë, enostoses. Most of the latter are, owever, inflammatory and probably syphilitic.

Cancellous exostoses upon the cranium are rare; ivory ones are more common, owing chiefly from the frontal bone and in the external auditory meatus. Sometes they are multiple and symmetrical. As a rule they are of very slow growth l should be left alone; but when they grow in the frontal sinus they may cause most fearful disfigurement from displacement of the eyeball, or even more ous symptoms from pressure upon the brain; while in the ear they may lead leafness and ultimately to complete obstruction of the meatus, with its conuences (acute suppurative osteitis and meningitis) if the secretion collects behind decomposes.

Fortunately, it frequently happens that the necks of these growths are much e slender than would be imagined from their size, so that they have even n known to break off. As a rule, they can be detached with a drill fitted to a ical engine, but very great care is required in the selection of proper instruits. In one or two instances the growths have detached themselves, like the ers of a stag, the vascular canals in the neck gradually becoming smaller and ller until at length the blood supply is altogether cut off.

*Sarcomata.*—Spindle-celled and myeloid sarcomata occasionally grow from diploë and cause expansion of the outer table. In some cases the two tables widely separated from each other, and the intervening space traversed by a plex arrangement of radially arranged trabeculæ. Occasionally the bone s way and the growth spreads rapidly under the skin, or compresses the dura er and the brain according to the direction it takes. There is usually a good of pain at the first, and the symptoms may be masked to a considerable extent he inflammation around.

Sarcoma of the dura mater (and more rarely of the other membranes) some-

times perforates the cranium and spreads rapidly underneath the scalp (fungus of the dura mater). This may be distinguished from the preceding by its pulsation (which is communicated from the brain beneath), reducibility (so long as it is small), and by the sharp opening in the skull through which it protrudes. Sometimes, also, the attempt at reduction gives rise to characteristic cerebral symptoms.

Excision is the proper treatment for both, if the diagnosis is made in time; but as a rule the disease is much too far advanced to justify an operation of such serious nature.

## DISEASES OF THE BRAIN AND MENINGES.

### INFLAMMATION.

Inflammation may begin in the brain (cerebritis) or the membranes (meningitis); or it may spread to them from structures around, the bones, the scalp, the mucous lining of the tympanum, or the eye. It may be acute, or chronic from the beginning, and it may end in resolution, or persist in a milder form; or, if pyogenic organisms gain entrance, lead to diffuse or circumscribed suppuration.

#### (*a*) *Simple Acute Inflammation.*

*Cerebritis.*—Inflammation of the brain may follow the reactionary stage of concussion, or may be caused by the intense hyperæmia that attends prolonged over-excitement. It is common after severe contusions, a zone of red softening, formed partly of broken down brain substance, partly of inflammatory exudation, developing around the injured area; and it is always found around abscesses (with the exception of the most chronic), in acute suppurative arachnitis, and to a less extent around rapidly growing tumors. When it follows concussion or is due to over-excitement, it is diffuse and involves the whole cortex of the brain; under other circumstances it is usually local, although it may be multiple and, sometimes at least, involve a very large area.

*Meningitis.*—Simple acute inflammation of the dura or pia mater is rare as a *primary* affection; it may, however, occur in compound fractures of the skull, caused by septic decomposition of extravasated blood (arachnitis, for example, may start from a fissured fracture of the petrous portion of the temporal bone, laying open the cavity of the tympanum and the prolongation of the arachnoid in the internal auditory meatus), and then it nearly always ends in suppuration. On the other hand, *consecutive* meningitis, due to extension from neighboring structures, is by no means uncommon. The infection may travel along the blood-vessels or lymphatics, by progressive thrombrosis (as in orbital cellulitis and diffuse inflammation of the scalp), or by embolism (as in pyæmia); or it may spread into the membranes directly from the adjacent structures, either the bones (most of the cases of acute suppurative meningitis after compound fractures are caused in this way) or the brain. In the one case the dura mater is attacked the first, in the other the pia; but although the pathological changes, hyperæmia, softening, exudation, and extravasation, may be more marked in the one than in the other, it rarely happens that the inflammation is limited.

**Morbid Appearances.**—In the early stages of the attack, and when the whole brain is affected, these are only slightly marked. The venous sinuses are full; the vessels of the pia and the plexuses engorged; the meshes of the arachnoid opaque and milky; the ventricles distended with turbid fluid; and the brain itself infiltrated, œdematous, and studded with minute red points like hemorrhages. In cases of longer standing, and when the mischief is limited, the affected part appears swollen and pulpy; if it is cut across the surface rises above the surrounding level; and the color is most conspicuous. Later still it becomes so soft that a gentle

[redacted]m of water washes it away, leaving an irregular excavation with ragged, [redacted]matous, and softened walls, breaking down at the slightest touch.

**Symptoms.**—The constitutional ones are merely those of acute pyrexia. [redacted]re is rarely a rigor; that is the signal for pyæmia or suppuration, but the [redacted]perature rises rapidly until sometimes it attains an extraordinary height; the [redacted]se becomes full, quick, and bounding; the respiration hurried and shallow; the [redacted]wels confined, and the appetite lost. The local ones, on the other hand, those [redacted]t depend upon the organ involved, exhibit a greater variety. Headache is [redacted]lways present, and usually is described as agonizing. At first there is general [redacted]yperæsthesia; the least noise causes intolerable suffering; the eyes cannot face [redacted]he light; the pupils are contracted to pin's points; and even the skin may be [redacted]exceedingly tender. Vomiting and delirium are rarely absent; sometimes there [redacted]s merely a certain amount of wandering at night, but not unfrequently there is a [redacted]ondition approaching that of furious mania. Then, by degrees, as the disorder [redacted]of the cortex becomes greater, the abnormal state of excitement passes into a con[redacted]dition of insensibility; the pupils dilate; the eyes remain staring widely open; [redacted]he breathing becomes stertorous; consciousness is lost, and stupor and coma set [redacted]in.

The character and extent of the cerebral symptoms vary with the seat of the disease. In some cases there is weakness of the limbs on the opposite side of the body; in others there are general convulsions. Occasionally, when, for example, the inflammation spreads from a contusion in or near the motor area, the spasmodic contraction is local at the first, and gradually extends from one group of muscles to another in definite order. On the other hand, when the attack commences in the bones, as in syphilitic osteitis, and spreads from them to the dura mater, it may be some time before any symptoms that are definitely cerebral make their appearance. There is no delirium or wandering in such a case; convulsions are not present until sometimes quite late; there is no intolerance of light or sound; but there is the most acute tenderness all over the inflamed bone, especially on percussion; the pain is intense, particularly at night; and if the base of the skull is involved optic neuritis and affections of the other cranial nerves, paralysis or neuralgia, are often present. Cases of this kind, in which the inflammation is local at the beginning and remains so for some considerable time, are naturally much less severe than those in which the pia mater and the cortex of the brain are involved from the first.

The course and termination depend chiefly upon the intensity and persistence of the exciting cause.

1. Resolution may take place if the irritant is mechanical and transient, an extravasation, for example, that becomes absorbed. Every severe contusion of the brain that does not prove fatal at once is surrrounded by a considerable area of red softening; and it is not uncommon for patients who have sustained injuries of this character to remain for two or three weeks in a very critical condition, feverish, exceedingly irritable, with photophobia, intense headache, quickened pulse, hot, dry skin, and often a certain degree of delirium. Then, at the end of that time, the temperature gradually falls and convalescence begins, although the least excitement or over-indulgence is sufficient to bring on a relapse.

2. Death may ensue, either because of the extent or importance of the part of the brain affected; or from exhaustion and the intensity of the fever.

3. The inflammation may become chronic if the irritant (without being pyogenic) is a persistent one. It may be a depressed plate of bone, or a foreign body driven in, or a cyst or patch of dense fibrous tissue developed from an old extravasation; or it may be a specific organism, such as that of syphilis, tubercle, or actinomycosis, sufficiently irritating to cause the production of a mass of granulation tissue, but not, at first at any rate, lowering the vitality of the surrounding structures so far that they become unable to withstand the action of pyogenic organisms.

usually runs an acute course, and ends in a speedily fatal form of menin-
when, however, it takes the shape of a caseous mass; deeply buried in the
ce of the brain, the chief symptom, until compression sets in, is the chronic
n of all the surrounding parts. Slowly growing tumors and cysts, whether
ing in the brain itself or springing from the bones, act in the same way.
sistent abuse of alcohol is said to cause the same result, leading to chronic
nation and induration of the membranes and surface of the brain, especially
vertex; and sometimes there are other causes, some acting directly, others
rise to reflex irritation, and others again affecting the circulation chiefly, if
irely, so that, *post-mortem*, no local pathological lesion can be found.

ymptoms of chronic irritation of the brain, whether sufficiently severe to
visible inflammatory changes or not, are of the most varied character. In
nstances they are entirely general, without the least indication of any local

A peculiar condition of general irritability, for example, is often left after
contusions. Recovery does not appear to be complete; there is a great ten-
to headache, especially after any mental exertion or excitement; the patient
able, giving way to fits of passion without any apparent reason; memory is
ve, sometimes generally, sometimes only for certain special things; the
of mental concentration is impaired, and the patient is quite unable to do
e used to do without effort before. It seems as if the circulation through
ain does not easily regain its power of self-control; for a long time the least
excitement or over-exertion is enough to throw it into disorder, and to
back, temporarily, the condition of hyperæmia and congestion that followed
iately upon the receipt of the injury. As a rule this passes off; but some-
if the part is not kept at rest, it becomes permanent, and a lasting condi-
cerebral incapacity is left.

he symptoms are the same when the irritant is a persisent one, but they are
more intense. Headache is never absent, sometimes it is general, sometimes
but wherever it is, it is always made worse by excitement, or by hanging the
own, or by the use of alcoholic stimulants. Vomiting, such as is met with
bral affections, apparently purposeless in character, is not infrequent. Ver-
ty occur, especially when suddenly rising up. Optic neuritis is nearly always
, especially when the membranes at the base are concerned; and in many
here are other affections—neuralgia, for example, or paralysis of the other
nerves.

me form of mental disturbance is rarely absent. It may be merely irrita-
nd wakefulness, with an uncertain temper; or there may be loss of memory
wer of concentration with want of mental vigor, and in extreme cases de-
. The local symptoms are no less variable. Spasmodic convulsions may
f the irritant affects the motor portion of the cortex, and without occasion-
y loss of consciousness, may spread from one centre to another. Traumatic
y may follow, the discharging lesion from constant repetition becoming per-
t. Or paralysis may occur, but this is less frequent, as lesions that cause
c irritation or inflammation are usually connected with the membranes or the
of the brain, and slow destruction of the cortical motor centres in one
here admits very largely of compensation.

aluable information, both as to the site and nature of the lesion, may fre-
y be obtained in other ways. In traumatic cases, for instance, there may be
ssion or irregularity on the surface of the skull. Pressure may be exceed-
ainful at one particular spot; or the whole bone may be tender on percus-
The pain may be altogether of a different character, dull and heavy, infin-
orse at night, due chiefly to the osteitis. The temperature of the part may
her than that of the corresponding point. The skin may be puffy or raised;
e may be evidence of obstruction to, or pressure upon, structures passing
ough canals in the bone; and these symptoms of course vary in every case.

### Suppuration.

Acute inflammation of the brain and its membranes may terminate in suppuration. The pus may form between the bone and the dura mater (subcranial) probably always extending inward from the bone; between the meninges (subdural); or in the substance of the brain. In this last situation the abscess may be separated from the external focus of disease from which it started by a layer of healthy brain tissue, and even by intact and unaffected membranes, the infection having traveled inward along one of the veins or in its perivascular sheath.

Suppuration is limited or not, according to the relative vigor of the tissues on the one hand and the irritants on the other. If the latter are much the stronger, it will be *diffuse* and set in acutely; if the difference is not so great, it may be *circumscribed*, two or three weeks being required for the development of the limiting wall of granulation tissue; and if the balance is only just in their favor, it may be *chronic* and even latent, remaining concealed perhaps for some years.

**Cause.**—Intracranial suppuration may originate in three different ways:—

(1) It may break out *after contusion or concussion of the brain*, even though the skin has not been injured or the bone fractured, the pyogenic organisms being carried by the blood, but not causing embolism. Fortunately it is very rare. It may be either diffuse, acute cerebritis running on to suppuration, and proving fatal within a few days, or circumscribed, the area of red softening round the contusion gradually growing more and more liquid in the centre until it simply becomes a collection of pus. Abscesses caused in this way are nearly always single and in the substance of the brain. Not unfrequently they are situated on the side opposite to the injury—in the right frontal or temporo-sphenoidal lobes, for example, when the blow has fallen upon the left side of the occiput, owing to the fact that in such cases this is the part of the brain that usually suffers most.

(2) It may be due to *pyæmia* consequent upon the impaction of infected emboli from some distant focus of suppuration (usually in the lungs). If it occurs in connection with the membranes it is always diffuse; if it is in the brain it is nearly always multiple and generally in the course of the middle cerebral artery.

(3) It may be due to *extension from suppuration near*. This, which is by far the most common and the most important variety, may be the result either of injury or disease.

(*a*) *After Injury*.—Acute suppurative meningitis may be caused either by the organisms entering through the wound directly, or by extension inward as a result of suppuration in the diploë.

In the former case the inflammation breaks out within a day or two after the injury. It usually occurs after small punctured fractures, not when the bone has been extensively comminuted and all the loose fragments have been removed. In these cases a considerable amount of blood is often extravasated; it collects in the wound exposed to the air, and so long as the fragments remain impacted is unable to escape. If septic decomposition is allowed to take place, the products soak into the bruised and damaged tissues around, and lower their vitality to such an extent that suppuration follows at once, and is always diffuse. The meshes of the pia mater are filled with exudation, which surrounds the veins, dips into the sulci, and covers the convolutions, until it can be stripped off like a cast of yellowish-green wax, bringing with it the surface of the softened and infiltrated cortex.

In the latter case, when the meningitis is secondary to acute suppurative osteitis, the appearances and the result are generally the same, although it may be several days before the disease is so far advanced. Sometimes, however, when the dura mater is not torn, the course is more protracted, and subcranial (extra-dural) suppuration occurs, and persists for some little time before the inflammation gains the subdural space and becomes diffuse; and, occasionally, even when the dura mater has been punctured and spicules of bone driven into the substance of the brain, there is no definite evidence of the formation of pus, though weeks may

ave passed since the receipt of the injury. Probably in this latter case there has een no septic decomposition, and the pyogenic organisms, with only a limited ass of damaged tissue at the seat of injury, without the assistance of the oisonous products of putrefaction, have only been able to cause the minimum of estruction.

In exceptional instances intracranial suppuration may follow a simple contu- ion of the cranial bones, suppurative osteitis breaking out at the seat of injury and xtending inward. A severe blow is received upon the head; blood is extrava- ated into the veins of the diploë and under the pericranium; usually it becomes bsorbed; occasionally days or weeks after the injury suppuration breaks out, the rganisms having entered from some already existing focus of suppuration, through a wound, or through the mucous membranes. At once the inflammation becomes much more severe; the pericranium is detached from the bone on one side and the dura mater on the other; the exudation pours out into all the tissues around, lifting up the skin (Pott's puffy tumor) and glueing together the membranes; acute osteophlebitis sets in, and the pus spreads rapidly through the softened and inflamed tissues. Suppurative osteitis of this character is so often associated with pyæmia, sometimes as its cause, that when the pus does burst through the bone it rarely remains limited; nearly always, however early an incision is made, the pericranium is already stripped up, the bone is bare, rough, and brown, and if a trephine is applied, pus wells out from the groove mixed with the bone-dust. When the disc is lifted out, instead of a circumscribed abscess, the dura mater is already perforated and the arachnoid and sub-arachnoid spaces are filled with a thick layer of yellowish-green pus.

(*b*) *As a Result of Disease.*—Intracranial suppuration is frequently caused by xtension inward from a purulent focus in the surrounding tissues, without fracture r other injury. The pathological process is essentially the same as when it follows n open wound or a compound fracture; the route, that is to say, may be direct, the icro-organisms simply invading one part after another and forming a continuous ack of suppuration; or the inflammation may spread along the veins or lym- atics without leaving in the intervening tissues any evidence of its passage through em; but the difficulty of localization is so great, and the onset of the disease in e majority of cases so insidious, that a separate description is advisable.

As in the case of compound fractures, the suppuration may be either *diffuse*, volving the membranes, or *circumscribed*, and usually in the substance of the rain (cerebral abscess); but the relative frequency of the two is very different.

The former, which is by far the most common after injury, is rarely met ith unless there is acute extra-cranial inflammation, such as orbital cellulitis, cial carbuncle, diffuse inflammation of the cellular tissue of the scalp, the -called phlegmonous erysipelas, or acute suppuration in connection with the ar. In all probability the infection extends along the veins or their sheaths, e ophthalmic for example, or the mastoid, or those that pass back through the henoidal fissure, for the meningitis is nearly always associated with thrombosis f the sinuses and general pyæmia. So far as the pathological appearances are oncerned, it does not differ in any material respect from the diffuse suppurative eningitis that occurs after compound fractures.

The latter (*cerebral abscess*) results almost always from chronic suppurative isease, and is usually consecutive to caries of the ethmoid, or especially the etrous portion of the temporal bone.

Catarrhal inflammation of the middle ear is exceedingly common after the xanthemata (particularly scarlatina and measles), and may occur whenever the mucous membrane of the throat becomes inflamed. In most cases it subsides ithout any ill consequence; but if it runs on to suppuration it may lead to per- oration of the membrana tympani and destruction of the auditory ossicles; or it ay become chronic, spread from the mucous membrane to the periosteum and e bone beneath, and give rise to caries and necrosis. When this takes place ere is always imminent danger that it may extend further still.

Extension may take place while the inflammation is acute, or later when it has become chronic, and there is nothing to attract attention but the loss of hearing and a little purulent discharge from time to time. In the former case, as in traumatic intracranial suppuration, it is usually diffuse; if the conditions are not favorable that the pyogenic germs can spread without difficulty through the petrous portion of the temporal bone to the meninges, they are not likely to remain localized and confined there. In the latter case it is nearly always circumscribed. So long as the exit is free and the discharge is not allowed to accumulate and decompose, the danger is not great, although suppuration does sometimes occur even under these conditions, the abscess remaining latent in the brain. If, however, the outlet becomes blocked, whether this is due to dried-up discharge or to the growth of polypoid granulations, the pus that is retained begins to decompose, the tension becomes higher and higher, and extension of the inflammation is the natural consequence. It depends chiefly upon the accidental anatomical relations of the focus of disease, whether the pyogenic organisms spread to the dura mater (causing subcranial abscess or diffuse meningitis), to the brain (finding a route by direct continuity of structure, or along the veins or lymphatics), or to the blood-vessels in the diploë, giving rise to osteophlebitis, thrombosis of the lateral sinus, or pyæmia.

These relations, and particularly the development of the mastoid cells, vary at different periods of life. In a child two years of age, there is only a small air space lying immediately behind the tympanum; the cells that occupy the mastoid process have as yet no existence, and the lamina of bone which forms the roof of the tympanum and helps to separate the external meatus from the middle fossa is exceedingly thin. On the other hand, in adults, the mastoid process may be excavated by great hollows quite up to the lateral sinus and the mastoid vein (especially when the sinus curves rather more forward than usual, for its position is very variable). Suppuration, therefore, in connection with the mastoid cells would tend to spread more easily toward the middle fossa in the child, toward the sinus in the adult; but further evidence is wanted to establish this as a fact.

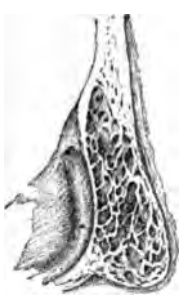


FIG. 291.—Section (slightly oblique) through the mastoid process and the lateral sinus, showing the relation they bear to each other in the adult.

In many cases, the inflammation spreads by direct continuity of structure; the bone becomes inflamed, and necroses; the dura mater over it sloughs, and either the pus spreads into and through the arachnoid space at once, or the membranes become glued to each other and to the cortex by inflammatory exudation before this can occur. There are, however, many other routes almost as direct, along which the infection may travel. It may spread, for example, down the internal auditory meatus, or through the hiatus Fallopii, or the aqueductus vestibuli, or it may extend along some of the numerous small veins (each surrounded by a perivascular lymph sheath) which run between the internal and middle ear on the one hand and the dura and pia mater on the other. Some of these pass directly from the temporo-sphenoidal lobe of the brain to the dura mater, covering the petrous portion of the temporal bone; others run through the squamo-petrosal suture, and through the slit for the dura mater that lies by the side of the aqueductus vestibuli; others, again, lie in small canals (immediately behind the superior semicircular canal) which connects the middle ear directly with the middle fossa of the skull; and not a few communicate with the middle meningeal veins and the superior petrosal and lateral sinuses.

In most cases of disease in the middle ear the abscess is in the temporo-sphenoidal lobe; sometimes the dura mater covering the anterior surface of the petrous portion is unaffected; generally it is sloughing, or at least inflamed. The abscess is usually of large size (an inch and a half or two inches in diameter); its walls may be very thick (occasionally acute suppuration develops round an old encysted

[illegible]cess); and it may lie in the substance of the lobe, covered over by a layer of [illegible]rently healthy cortex a quarter of an inch in thickness, or communicate with [illegible] suppurating focus in the bone through a sinuous channel. The pus is generally [illegible]ceedingly fœtid. The abscess if left to itself may remain latent for years; or [illegible]te symptoms may suddenly develop from some comparatively trivial cause, [illegible]posure to cold for example, or a blow upon the ear: usually it terminates sooner [illegible] later by rupturing into the lateral ventricle or the subarachnoid space.

Cerebellar abscess is less frequently met with. There is a certain amount of [illegible]idence that it is more common, comparatively, in children than in adults and [illegible]hen the mastoid cells are inflamed. Thrombosis of the lateral sinus is associated [illegible]ith it in many instances.

Abscesses in many localities are more rare: but they are sometimes found between the dura mater and the bone (extra-dural); in the centrum ovale; even on the opposite side of the head (probably pyæmic, or at least thrombotic; and in the pons. It is said that the last is consecutive to disease of the internal rather than of the middle ear.

In comparison with this, intracranial suppuration consequent on disease of bone elsewhere, is seldom met with. Both forms, however, the diffuse and the circumscribed, may occur in the region of the frontal lobes from caries of the ethmoid and ozæna; and one or two instances are recorded in which the same thing has happened in connection with the orbit.

**Symptoms.**—1. *Diffuse Suppuration.*—It is rarely possible to tell when suppuration begins in a case of acute inflammation of the brain. Sometimes there is a rigor, but it is by no means invariable, and if it does occur it more frequently indicates the commencement of pyæmia. The constitutional symptoms simply grow more and more severe, the temperature in particular rising to an exceptional height, while the local ones gradually merge into those of compression. The cortex becomes more and more disordered; convulsions, excitement, and delirium give way to paralysis, loss of consciousness, and coma; the pupils dilate; the eyes remain widely open; the face becomes flushed and dusky; the pulse slow and full; and respiration labored and stertorous.

2. *Intracranial Abscess.*—The symptoms depend upon the rapidity with which it is formed, the rate at which it extends and the locality in which it occurs. In rare instances intracranial abscesses are acute, ushered in with a rigor and high fever. Much more often they are chronic and even latent, without any elevation of temperature; sometimes there is an actual fall, so that, for a time at least, it is subnormal. Occasionally, after existing without a symptom for an indefinite period, an abscess suddenly becomes acute, spreads rapidly, and breaks into the ventricular or subarachnoid space. The local symptoms are those of pressure upon or irritation of the structures that lie around it.

The most important varieties are the traumatic and that which is secondary to disease of the middle ear. Others are more rare and seldom admit of diagnosis.

(*a*) *Traumatic Intracranial Abscess.*—The symptoms are partly general, indicative of disturbance of the whole nervous system; partly local, arising from affections of special portions of the brain, or the nerves, or the bones and membranes covering them in.

There is always a latent period after the accident, at least a fortnight, generally much longer, sometimes years. At the time there may have been concussion, or evidence of contusion of the brain; but in a typical example this has passed away. Recovery, however, is not perfect; the patient grows thinner, or loses his memory; perhaps he becomes irritable, or there is general failure of power, bodily as well as mental. Sometimes these signs are so marked that the friends notice them and become anxious; sometimes they are scarcely perceptible. The temperature is usually subnormal, although slight chills may occur, the pulse is quick and irritable at first, very slow toward the end. Pain is rarely absent; in most cases it is very severe; usually it is general, affecting the whole head; sometimes

it is local, and associated with great tenderness on pressure or percussion. Optic neuritis is present in nearly every case, and irregularity of the pupils is often noted, the one that is more dilated and fixed corresponding to the affected side. Very often local signs are entirely wanting; there is merely headache followed by drowsiness, paralysis, and at length coma, without its being possible to say from the brain symptoms more than that it is a case of gradual compression.

Valuable information is often gained from the condition of the skin or the bone. Sometimes there is a scar or an irregularity on the surface of the cranium from depression of a portion of bone. In many instances there has been a history of purulent discharge following fracture, and of very protracted healing. Occasionally the discharge has stopped, collected, and begun again more than once before the symptoms became serious, although each time there may have been a certain degree of headache and feverishness. Tenderness on percussion over the affected bone is not uncommon. Sometimes there is a dull, aching pain, especially severe at night. In a few cases there is a soft puffy swelling on the scalp, due to effusion under the pericranium (Pott's puffy tumor), and pointing to commencing suppuration in the diploë.

Intense neuralgia in all the three branches of the fifth pair has been noted once or twice. Paresis from pressure, occasionally passing into paralysis, is more common, affecting especially the motor nerves of the eyeball.

Cerebral symptoms, monospasm and monoplegia, gradually extending over a wider area, are rare. They only occur when the motor area is involved, and are not always present then. When cerebral abscess is caused by *contre-coup* they are the only local signs that are present.

**Diagnosis.**—*Diffuse suppurative meningitis* usually runs a much more rapid course; it begins within a short time of the injury, almost always in the first week, sometimes in forty-eight hours, and is associated with high fever, headache, delirium, and other signs of rapidly-spreading destruction of the cortex.

*Chronic meningitis* is often present as a complication in cerebral abscess; by itself it does not give rise to symptoms of compression.

*Pyæmia* is the most difficult, especially when it commences as osteophlebitis in the injured portion of the cranium. The difference is merely in the method of extension. Each commences, in many cases at any rate, as a purulent osteitis, with a soft, puffy, and exceedingly tender swelling upon the scalp. In the one, the suppuration spreads through the contiguous structures to the membranes and the brain beneath, until an abscess is formed. In the other the veins of the diploë and the sinuses are thrombosed, and the infective emboli carried off to cause abscesses elsewhere. The local signs are the same; the early constitutional ones present no material difference; a single rigor may occur in either; indeed it is not until pyæmia has shown its presence by local indications in other parts of the body, or by repeated shivering fits, that the diagnosis is certain. The difficulty is not so great when cerebral abscesses are dependent upon other causes than disease of bone, but then, not unfrequently, all but the most general symptoms are wanting altogether.

(*b*) *Intracranial Abscess Due to Disease of the Middle or Internal Ear.*—Nearly three-fourths of these are situated in the temporo-sphenoidal lobe, and many are associated with a sloughing condition of the dura mater. The rest occur in the cerebellum, between the dura and the bone, in the pons, and occasionally in distant parts of the brain. They never appear while the inflammation is acute; there is always a history of chronic purulent discharge lasting for years, and often of its having stopped on some previous occasion which was marked by severe headache, vomiting, and perhaps other symptoms.

In most instances two stages can be distinguished; the first, while the abscess is slowly forming, of very indefinite length; the second, that of rapid extension, rarely lasting more than a week. The transition may be gradual, but more often it is sudden, caused by some comparatively trivial accident, such as a blow upon the ear or exposure to cold and wet. Many apparently unaccountable cases of

[illegible]l coma are explained in this way; an old cerebral abscess, which has already [illegible]ted weeks or months without giving rise to any definite symptoms, suddenly [illegible]ving way and bursting into the ventricular or subarachnoid space.

The symptoms in the early stage are vague and ill-defined. There is always [illegible]adache, sometimes very severe, and, not unfrequently, vomiting without any [illegible]pparent reason, as is usual in cerebral affections; but in many, the only sign is a [illegible]ull, sluggish state of mind, sometimes uniformly lethargic, sometimes, on the [illegible]ther hand, diversified by strange fits of irritability, and, in rare cases, delirium [illegible]nd convulsions. Rigors, pyrexia, and optic neuritis seldom occur.

In the acute stage, the symptoms present the same general characters but they [illegible]re infinitely more severe. The headache is of the most intense description, [illegible]adiating from the ear and causing such fearful agony that the patient can do [illegible]othing but scream or rock himself from side to side, clasping his head in his [illegible]ands or burying it in the pillow. The lethargy rapidly deepens into stupor; [illegible]here may be an attack of vomiting or a single rigor, but this is more commonly [illegible]ssociated with subdural abscess and thrombosis of the lateral sinus; the face becomes dark and cyanosed, the respiration labored and stertorous, and coma, with or without convulsions, quickly follows. Death usually takes place within the [illegible]week, sometimes within a few hours.

**Diagnosis.**—An accumulation of decomposing *pus, pent up in the mastoid [illegible]ntrum*, may cause many of the symptoms of cerebral abscess, including, according to Barker, double optic neuritis. In any case of doubt a preliminary explor[illegible]tion should be made, a trephine or gouge applied to the outer wall half an inch [illegible]ehind and above the centre of the external meatus, the cavity thoroughly opened [illegible]nd washed out. This difficulty of course only occurs in the early period of the [illegible]isease, before there are any symptoms of compression.

*Thrombosis of the Lateral Sinus.*—According to Pott, this is usually due to [illegible]irect extension from the bone on the posterior surface of the petrous part; more [illegible]rely from the mastoid cells along the vein of the cochlea. The clotting may be [illegible]cal or extend into the other sinuses and down into the jugular vein. When due [illegible]o osteitis it nearly always proves fatal from pyæmia. The symptoms resemble to [illegible]me extent those of cerebral abscess, but there is usually a rigor, or at least a [illegible]ery irregular temperature; the pain is more local; there is a tendency to retract [illegible]he head; the neck is stiff; and occasionally subcutaneous œdema may be noted [illegible]ver the mastoid, or the internal jugular vein can be felt as a hardened cord in [illegible]he neck. Optic neuritis, vomiting, headache, giddiness, and even coma may be [illegible]resent in these cases before any clearly pyæmic symptoms make their appearance. [illegible]Hitherto these cases have been regarded as practically hopeless: it has, however, [illegible]een shown by Ballance and others that recovery is possible even after pyæmic [illegible]ymptoms have made their appearance in distant parts of the body, if only the [illegible]isease is treated thoroughly. The mastoid antrum must be cleared out first: if [illegible]othing is found in it to account for the symptoms, or if, in spite of this having [illegible]een done, the pyrexia and irregular temperature continue, the orifice of the [illegible]astoid vein (an inch and a quarter behind the meatus) should be exposed, and if [illegible]t is thrombosed a further operation undertaken. The jugular vein must be liga[illegible]ured in the neck; the whole of the dead bone between the meatus and the wall [illegible]of the lateral sinus cut away, so that there may be free exit for the pus that lies [illegible]etween the membranes and the bone; and the cavity that is left, the sinus itself, [illegible]nd the upper part of the vein thoroughly syringed out with a solution of corrosive [illegible]ublimate.

*Subdural abscess* may form on the posterior surface of the petrous portion of [illegible]he temporal bone, or over the roof of the tympanum close to the squamoso-[illegible]petrosal suture. In the former locality it is nearly always associated with throm[illegible]bosis of the lateral sinus, the pus spreading between the dura mater and the bone [illegible]until it reaches the fibrous wall and so alters the endothelium that a clot forms [illegible]upon it. In the latter, it may occur independently by itself. It is very doubtful, [illegible]when it exists by itself, whether it can be distinguished from cerebral abscess;

rigors appear to be more common; percussion over the temporal bone is more painful and the cerebral symptoms are less distinct; but the two may be associated together. The diagnosis is not perhaps of so much importance, as in any case in which the symptoms continued after the mastoid cells had been cleared exploration must be continued in the same direction: behind the mastoid process if there is any evidence of sinus thrombosis, above and slightly in front (so as to expose the anterior surface of the petrous part) if there is not.

*The diagnosis of the locality* of cerebral abscess, when consecutive to otitis, is equally difficult. The majority are situated in the temporo-sphenoidal lobe, especially in the case of adults; of the rest, most are in the lateral lobe of the cerebellum, the others are practically inaccessible.

An abscess in the temporo-sphenoidal lobe does not cause any localizing symptoms until it has attained a very considerable size. As it increases, the third nerve on the same side becomes compressed, so that ptosis, fixed mydriasis, and paresis of the ocular muscles ensue; and then the lower part of the ascending frontal and parietal convolutions, so that the facial muscles on the opposite side of the body become paralyzed (retaining, however, some power of emotional expression), and then, later, those of the arm. The leg is never affected; and sensibility remains unimpaired.

Cerebellar abscess is still more indefinite. It appears to be relatively more common in the young, and there is no doubt that it is often associated with thrombosis of the lateral sinus. Severe occipital pain, persistent vomiting, and retraction of the head are suggestive of its presence; but unless there is definite evidence of disease of the posterior surface of the petrous portion, exploration for cerebellar abscess should never be made until the existence of a temporo-sphenoidal one has been excluded.

**Prognosis.**—Intra-cranial suppuration, whether traumatic or consecutive, if left to itself is practically hopeless. A few cases have recovered, the former by the cicatrix giving way so that the pus was discharged externally, the latter owing to the abscess becoming surrounded by a dense capsule; but the number is very small. Death may be caused by compression, or by the abscess rupturing suddenly into the ventricles. Occasionally a condition of marasmus sets in and proves fatal without any definite reason; and sometimes sudden death occurs, as in the case of cerebral tumors.

*General Treatment of Inflammation of the Brain.*—1. *Preventive.*—If there is a wound no effort should be spared to free the surface from all possible sources of irritation, whether mechanical, such as depressed fragments of bone, or chemical, such as the products of decomposition; and to secure perfect drainage, so that there may be no retention of lymph and no tension. In the same way, if there is suppuration in connection with the middle ear, and the membrana tympani is bulged outward by a quantity of opaque white pus, it should be incised from top to bottom behind the malleus, and transversely below it, and the cavity thoroughly drained. Still more is this necessary if the disease has already involved the bone, so that a foul collection of decomposing pus lies buried behind the meatus.

If there is no wound, but merely a history of a severe blow upon the head, followed perhaps by symptoms of concussion or contusion of the brain, absolute rest must be enforced. Everything that causes hyperæmia of the brain—mental exertion, excitement, want of rest, stimulants, even conversation—is injurious, and tends to delay recovery. The head should be shaved, cold applied, the room darkened, the bowels thoroughly opened (preferably with calomel) and only the lightest diet allowed; nor should any precaution be omitted until a sufficient time has elapsed for the extravasated blood to become absorbed and the damaged tissue repaired. In other parts of the body this often takes a fortnight or three weeks: and there is no proof that a shorter time is required in the case of the brain.

2. *Curative.*—(*a*) *Acute Inflammation.*—If, in spite of this, the symptoms of acute inflammation, the headache, pyrexia, and delirium, grow worse, leeches may be applied behind the ears; venesection may be tried; the calomel may be repeated

as to produce copious evacuation, and if there is great excitement small doses of opium, or, better, bromide of potassium and chloral, may be given; but if the inflammation is general, if no local cause can be found and removed, there is very little hope; it is almost sure to run on to diffuse suppuration.

(*b*) *Chronic Inflammation.*—The treatment depends upon whether a local cause can be found or not. If there is a tender spot on the bone corresponding to an old injury, or a depression, or a suspicion of some alteration on the inner surface, such as splintering of the inner table, thickening of the dura mater, or the formation of a cyst in the arachnoid, the cicatrix should be reopened, the periosteum reflected, and a circle of bone removed with the trephine. If nothing is found to account for the symptoms, the dura mater should be examined too and incised; and if the brain projects upward into the wound, indicating a certain amount of pressure, it should be explored with a grooved needle or a fine trocar and cannula. Possibly there may be a chronic abscess or a cyst. If nothing is discovered, the dura mater should be readjusted, sutured or not, according to the size of the opening, and the bone, provided it is not thickened or sclerosed, replaced again.

Where there are no local symptoms, but merely, instead of perfect convalescence, a condition of irritability, excitement, or headache, great relief may be obtained by counter-irritation, blisters, and even setons. Mercury pushed to salivation has been strongly recommended; iodide of potash is also said to have been of service; but probably most reliance must be placed upon the effect of time and perfect rest. Change of air and scene, and the avoidance of everything that can cause cerebral hyperæmia, naturally suggest themselves, and, of course, special attention should be paid to the presence of any diathesis, such as syphilis or gout.

(*c*) *Intracranial suppuration* can only be treated by operation. The diffuse form in which the whole surface of one hemisphere is covered over with a layer of pus, dipping down into the sulci and sheathing all the vessels, is practically beyond reach. The localized one requires trephining.

*In traumatic cases* there can be no question. Except in those rare instances in which the abscess has developed as a result of *contre-coup* (and they rarely admit of diagnosis), an exploratory operation should be performed at the seat of injury; and when the brain is exposed, if the cause still remains undiscovered, a grooved needle should be thrust into it in all directions. Many cases have been relieved in this way, some temporarily, the immediate symptoms of compression passing away, so that the patient recovered consciousness and the pulse regained its vigor (I have, on several occasions, seen all the vessels in the scalp begin to pulsate as soon as the tension was relieved); others permanently, recovery having been complete.

The same thing holds good with regard to cases that are *consecutive to middle ear disease*, but the difficulty is much greater. Other affections, especially thrombosis of the lateral sinus and pyæmia, are caused in the same way and give rise to very much the same symptoms; and even when these are excluded there is often no definite evidence as to locality. In all such the mastoid antrum should be thoroughly explored first, and a free communication established between it and the external auditory meatus: in many instances relief is obtained at once by this, the incipient meningitis, which is probably the cause of the cerebral symptoms, subsiding as soon as the cause is removed. If this does not succeed, or if no evidence of accumulated pus is found, the exploration must be carried further. Whether it should be made half an inch above and slightly in front of the meatus, so as to expose the anterior surface of the petrous portion, or behind and on the same level, must be guided by what is known of the condition of the sinus. In either case, the exit must be as free as possible, not only for the pus in the brain, but for all the gangrenous shreds of dura mater.

In all cases the orifice of the mastoid vein must be exposed first. If this gives no evidence of thrombosis, and there is no other sign, the anterior operation

should be selected, the under surface of the temporo-sphenoidal lobe exposed, and if there is no extra-dural collection of pus, thoroughly explored with a groove needle. If, on the other hand, there is any symptom pointing to the sinus, the bone should be removed from behind the meatus; and if an extra-dural abscess and septic thrombosis are found, the jugular vein should be ligatured too. The only hope lies in thoroughly clearing out the clot and removing the whole focus of disease.

If no abscess is found in the anterior operation, either between the dura mater and the bone, or in the substance of the brain, and there is no evidence of thrombosis, even when the mastoid vein is exposed, the periosteum and the muscular attachments must be separated from the occipital bone beneath the superior curved line, and the lateral lobe of the cerebellum explored. In many cases of cerebellar abscess, however, there is sinus thrombosis as well, and there must always be considerable danger of one of the two being overlooked if the other is found.

## Hernia Cerebri.

Hernia cerebri is a protrusion through an opening in the cranium of brain substance that has been softened by inflammation; and it is caused by the difference between the external and the internal pressure.

When a portion of the brain is excised the cavity fills almost at once, and the edges of the incision become everted. If the scalp is laid down again, and union takes place by the first intention (protection being afforded in the meantime by the dressings), the outside tension is restored and there is merely a slight sinking inward, corresponding to the amount of tissue removed. (Sometimes, when, for example, the loss has been very great, and the walls cannot fall in, a serous cyst forms to fill up.) If, on the other hand, inflammation sets in instead of repair, the brain tissue becomes softened, the intracranial tension rises higher and higher, and either symptoms of compression follow, or the pulpy brain substance is squeezed out through the opening.

The defect in the cranial walls may be caused by injury (compound fractures wounding the membranes), or by necrosis, syphilitic or otherwise, causing gradual softening of the dura mater.

The inflammation of the brain may be produced by any of the causes already mentioned (the area of red softening, for example, that exists round a rapidly growing tumor might lead to the development of a hernia after excision); but inasmuch as nearly all the cases of inflammation that coexist with an opening in the cranium are due to decomposition of the extravasated blood and end in suppuration, hernia cerebri is almost always regarded as the product of suppurative meningitis. The protrusion, in cases of injury, consists at first of extravasated blood mixed with inflammatory exudation; later of the latter with a varying proportion of softened and broken down brain tissue. In cases of necrosis the first layer naturally is wanting. As the tension increases and the process of softening extends, more and more of the underlying brain tissue is forced out, until sometimes, if the protrusion is sliced off, the cavity of one of the ventricles is laid open.

Fig. 292.—Hernia Cerebri.

It is more frequent in the young than in the old; in the frontal than in the parietal region; and it is more likely to occur when the opening is small than

hen the cranial bones are extensively comminuted. The appearance is unmis-akable. There is a soft, dark-brown mass, covered over with lymph or pus, leeding at the slightest touch, and pulsating synchronously with the brain. It ay grow rapidly, becoming more and more œdematous as it protrudes from a arrow opening, or the increase may be very slow; and after a time it may cease ltogether, shrink back of itself, and skin over. Recovery may take place even fter large masses have sloughed away, the space left in the cranium being filled ith clear serous fluid; more frequently the meningitis proves fatal.

Hernia cerebri is always the result of inflammation; if this is local and circumscribed, and the products can escape freely, the hernia gradually sinks back and skins over; if it is diffuse, nothing is of much avail. An ice-bag must be laid upon the head, and the ordinary treatment adopted for inflammation of the brain. The protrusion itself must be kept perfectly clean; it is no use either applying pressure or shaving it off. The prognosis depends upon the inflammation.

### Intracranial Tumors.

In 1884, relying entirely upon the clinical evidence of a focal lesion, Godlee exposed the surface of the brain and removed a tumor from beneath the cortex. Since then the same operation has been performed on many occasions by MacEwen, Horsley, and others with very considerable success. Unhappily the conditions are so stringent that the proportion of cases in which relief by operation is possible is very small. Localization must be exact; the site must be accessible; the size of the tumor must not be too great, or the lesion left may be practically as bad; and there must be no other growth or disease. Success is naturally more probable when the tumor is surrounded by a capsule than when it is of an infiltrating nature, but this it is rarely possible to determine beforehand.

The tumors that are grouped together under this class may grow from the bones, the membranes, or the brain. Some are primary, others secondary, the original lesion occurring elsewhere.

(*a*) *In Connection with the Bones.*—Tumors (other than syphilitic or inflammatory outgrowths) springing from the inner surface of the inner table of the skull are very rare. Myeloid sarcoma is not uncommon in the diploë, and ivory osteoses may grow from the frontal or other sinuses: and both of these may cause very serious inward projection of the bone: but they usually admit of speedy cognition from the exterior, and in any case require to be dealt with on their wn merits.

(*b*) *In Connection with the Membranes.*—Fibromata have been described in nnection with the dura mater. Sarcomata are rather more common, sometimes using absorption of the bone lying over them (the so-called fungus of the dura ater), and seriously compressing, but not invading, the brain beneath. Cysts, ssibly originating in old extravasations, are met with from time to time in the achnoid cavity, sometimes free, sometimes attached: hydatids have been known occur; and occasionally other tumors, plexiform angeio-sarcoma or endothema (in which the walls of the vessels appear as if they were converted into coma tissue), psammoma, chondroma, etc., of little clinical importance.

(*c*) *In the Brain.*—Three-fourths of the tumors that occur in the substance of brain are either gummata or caseous masses of tuberculous material. The mer, which nearly always occur in connection with the membranes or the vessels they dip through the cortex, are very irregular in shape and size, and usually sent on section surface masses of spots of caseation separate from each other firmer tracts of fibrous tissue. So long as they are shut in by the surrounding in-tissue is softened and necrosed, after absorption there is merely a dense, lurated star- [illegible] ing the brain down to the ventricles, and spread- ; in its [illegible].

Tumors [illegible] are [illegible] and uniform in [illegible] in section. As in them so long as they are

spreading (and they may attain the size of a pigeon's egg) is a zone of gray granulations, spreading along the vessels; later they may soften and form a caseous abscess, or develop into fibrous tissue, or dry up and undergo calcification. Naturally they are more common in the young, while gummata are generally met with in adult life. In many cases they are multiple (more than half, according to Gowers), and not unfrequently are associated with tubercular disease of the membranes and other organs.

Gliomata are the next most common. They are composed of tissue resembling to some extent the neuroglia of the brain, but they vary very much in consistence, and the softer ones are often stained with old and recent extravasations. They differ from the former and from other kinds of sarcomata in their infiltrating character, spreading among the nerve elements without any defined outline.

Other forms of sarcoma are more rare. Carcinoma has been described as a primary affection of the brain, and occasionally other tumors and deposits of actinomycosis.

Dermoid cysts have been known to occur, sometimes projecting on the exterior of the cranium through the bone. Hydatids and cysticerci are occasionally found both in connection with the membranes and the brain. Most of the serous cysts that have been described have originated in all probability either in the interior of sarcomata or in connection with old injuries and extravasations.

**Symptoms.**—Some of these are general, occurring more or less with all tumors, whatever position they occupy inside the cranium; others are localizing and are only present when certain parts are involved.

(*a*) Headache, due in great measure to the tension upon the fibrous structures; vomiting, apparently without cause or object, and especially on waking; vertigo on suddenly rising up; optic neuritis; mental dullness, and lethargy are the most prominent and the most constant among the former. For a full account, special works, such as those by Gowers and Bramwell, must be consulted.

(*b*) These may be due to interference with the cortex, the conducting paths, the nerves, or the walls. The more rapid the growth and the greater the amount of irritation and inflammation it causes in the tissues around it, the more distinct they are.

Lesions of the cortex may lead to perversion or abolition of its function. If the part involved is motor there may be localized epileptiform convulsions (the most valuable sign of all), followed by loss of power in the muscles most concerned, without any loss of consciousness. Nearly always this is due to some coarse lesion, and most often a tumor. Greater pressure causes paralysis at once, extending in a definite order. When the part is not a motor one, the indications are much less distinct; but as mind-blindness has been caused by a spicule of bone driven into the angular gyrus and has been cured by its removal, it is possible that similar evidence may be obtained of the growth of a tumor. The presence of a visual aura at the same time would render this much more probable.

Lesions of the conducting paths are attended in the same way by abolition or perversion of function; but in this case the former (manifested as paralysis or anæsthesia, according to the part involved, without any sign of irritation) is much the more prominent. If the internal capsule is concerned there may be hemianæsthesia or hemiplegia; if the lesion is lower, mixed or irregular forms, the muscles that are paralyzed on the same side as the lesion becoming atrophied and exhibiting the reactions of degeneration. If the paralysis is incomplete, and particularly if it is variable, there may be only pressure on the fibres without destruction; but unless this can be clearly proved to be the case, it is very improbable that the lesion is within reach, or if it is, that it is not too large.

Pressure upon the cranial nerves is often of great value in localization: neuralgia of all the branches of the fifth pair upon one side, for example, or anæsthesia limited to the same region, pointing definitely to intracanial pressure upon the trunk before its division.

Affections of the walls have been already mentioned; they are rarely present when the growth originates in the brain, until, that is to say, it has attained a size that precludes interference.

**Diagnosis.**—Bright's disease and advanced forms of lead poisoning may both be attended by optic neuritis, vomiting, headache, and convulsions. Anæmia and hypermetropia occurring together may occasion a momentary difficulty, a slight degree of optic neuritis and sometimes other symptoms being met with under these conditions; but the presence of a disorder connected with vision and the absence of localizing symptoms are usually sufficient. It is not so easy with paroxysmal hemicrania, especially when it is associated with hysteria, for the presence of one disease is not absolute proof that there is no other. Cerebral or cerebellar abscess very rarely occurs without a history of injury or evidence of diseased bone. Localized meningitis cannot always be distinguished, as it is present in many forms of tumor, especially syphilitic and tubercular ones, and furnishes some of the symptoms upon which the diagnosis rests.

The diagnosis of the kind of tumor is much more difficult. Age, as already mentioned, is of importance, but at the best it only indicates a slight degree of probability. Definite evidence, either from the history or from lesions in other parts of the body, of a syphilitic or tubercular diathesis is very significant, and should influence the line of treatment very materially, but it cannot be regarded as conclusive. Pseudo-apoplectic attacks are more common in connection with glioma and gummata than with other forms. A positive diagnosis, however, specially in the early stages, is very often out of the question.

**Prognosis.**—Syphilitic gummata may be absorbed, and all the symptoms disappear, if only the treatment is commenced sufficiently soon and carried out consistently. If they have already caused extensive destruction of the nerve-tissue around, that of course cannot be replaced; and it is possible that the cicatrix left, dragging upon the brain and anchoring it to the membrane, may sometimes of itself lead to serious after trouble. It is probable, too, that tubercular masses are sometimes absorbed or dried up; certainly they not unfrequently remain latent for long periods, but there is not nearly the same degree of control over them. Other tumors pursue their course relentlessly, sometimes leading to coma and compression, or destroying life by the intensity of the pain that accompanies them, sometimes leading to a condition of marasmus, or suddenly causing death by interfering with the respiratory centre in the medulla.

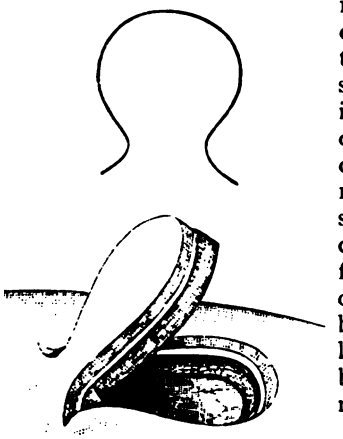
**Treatment.**—From what has been already said it is clear that, except in the case of gummata and some tuberculous masses, there is little or no hope for diseases of this class except in operation; and that even then the proportion in which this is practicable is a very small one. Nor is there much prospect that, with only our present methods of investigation, it will be materially increased; for the difficulty does not arise so much from the size of the tumor (although this has occurred) as from the impossibility either of localizing it or of gaining access to it. If the conditions are favorable, and it is decided to make the attempt, the directions given by Horsley should be followed.

The head should be shaved, washed with soft soap and ether, and thoroughly purified with an antiseptic, the site of the lesion having first been ascertained by measurement and definitely marked. A quarter of a grain of morphia is given before the operation, and the anæsthetic used is chloroform. This has the great advantage of causing contraction of the cerebral arterioles and so diminishing the amount of bleeding; but very great care is required in the management of the anæsthetic, and a very small quantity should be given.

The flap reflected must be of sufficient size, carried right down to the bone at once, so as to bring the periosteum with it, and so arranged that while its main blood-vessels are kept intact, dependent openings are left for drainage. The bone is most easily removed by taking out an inch disc with a trephine to learn the thickness, and then cutting out the piece required with a circular saw mounted on a surgical engine, the separation being completed with bone-forceps; or two tre-

hine openings may be made, one at each end of the exposed area, and the inter- ening tissues divided with Hey's saw. All the fragments should be carefully pre- rved between warm carbolic sponges or in a warm dilute carbolic solution, for eimplantation.

[The osteo-plastic resection is preferable in most cases, because by this ıethod the bone disc is preserved.]



G. 293.—Osteoplastic Resection, showing calp with Bone Flap. (*After Esmarch.*)

The natural color of the healthy dura mater is difficult to describe. The fibres of which it is composed run in coarse interlacing bundles, so that its surface is irregularly fasciculated; and showing up through them more or less distinctly is the purplish tint of the vascular brain. In cases of tumor it is sometimes reddened and vascular itself, at others adherent to the growth beneath and more yellow. The line of incision should run round four-fifths of the circumference of the area exposed, at one-eighth inch distance from the margin of the bone, so that the edges can be stitched together afterward. The main branches of the meningeal artery, if they lie in the line of the incision, should be secured by ligature before division. Adherent portions of the dura mater must be removed.

In cases of cerebral tumor, in which there is increased intracranial tension, the brain protrudes into the wound as soon as the dura is divided. If the growth does not occupy the surface, an attempt ıust be made to ascertain its position by the difference in color or consistence of ıe parts of the cortex exposed. Horsley suggests that particular attention should e paid to the presence of any white patches along the course of the cerebral essels, as indicating old mischief. In several cases an exploratory incision into ıe substance of the cortex has been necessary.

The arteries that supply the brain are terminal, so that, where it is possible, very main vessel should be left intact; but, as Horsley points out, they can sometimes be raised from the surface of the brain and even drawn out of the sulci ithout inflicting irreparable damage upon them.

The incisions through the cortex must be exactly vertical, directed into ıe corona radiata, avoiding, as far as possible, any injury to other fibres, those, r example, running toward the internal capsule. The gap left by removal f a portion of brain fills up at once, the corona radiata bulging upward and ıe cut edges becoming slightly everted; so that, owing to the mechanical relaons between the brain and the skull, there is normally a tendency to hernia erebri.

The edges of the dura mater are accurately secured by silk and horsehair itures. In his earlier operations, Horsley used a drainage-tube for twenty-four ours: later, he discarded this, and merely leaves one inch, unsecured, at the most ependent part.

The fragments of bone should be replaced *in situ* in a kind of mosaic; there no question as to their vitality being retained or their power of contracting adesions to the pericranium above and the dura mater below; and so far there is no oubt they add greatly to the security of the flap; but it is not certain how far ıere is any production of new bone.

Horsley follows Lister's principles strictly, making use of the carbolic spray ıd carbolic gauze. At the end of five or six days the wound is covered with owdered boracic acid, cotton-wool, and collodion. The scalp usually tends to ll in a little at the seat of the operation, but the cicatrix becomes exceedingly rong

## Trephining.

Trephining is performed either as a precaution to prevent irritation and inflammation of the dura mater by fragments of bone and to secure thorough cleansing, or to procure relief from symptoms that are already present. In the former case, the prognosis, so far as the operation is concerned, is exceedingly good; in the latter, it can scarcely be said to add very much to the risk. If, for example, there is compression of the brain, whether it arises from extravasation of blood, from pus, or from the presence of a new growth, or if a bullet has traversed the brain, and fissured the opposite side of the skull, or if insanity or epilepsy follows an injury to the head, trephining may be the only chance of affording relief; but when done under such circumstances as these, for the removal of a condition that has almost proved fatal already, it ought not to receive the whole blame of the result.

The bone is exposed either by enlarging the original wound or by reflecting a flap of skin in such a direction as to secure a dependent opening for drainage (when the patient is lying down) without endangering the blood-supply. The pericranium is best preserved by reflecting it in the flap, laying the bone bare at once. In most cases where mere elevation is required, enough may be accomplished by sawing off a projecting angle or cutting a channel with Hoffman's gouge-forceps without actually using the trephine. If, however, the original opening in the bone is not large enough for this, a portion must be removed to begin with. The centre pin of the instrument is screwed tight so as to project a little below the edge of the crown, and placed upon the centre of the part that is to be cut away. Then it is worked, with alternate pronation and supination, until a groove is cut in the bone sufficiently deep to prevent slipping. As soon as this is done, the pin is withdrawn to avoid injury to the membranes. The external table is exceedingly hard to saw; the diploë, on the other hand, gives way with ease, and as soon as this is reached the groove becomes filled with soft debris mixed with blood. The inner table, again, is harder, but it is generally possible, when this is partially sawn through, to detach the circle by gently rocking the trephine from side to side, or by means of an elevator. It must, of course, be recollected that the skull is not of the same thickness all over; that in some places the diploë is wanting, and also that, owing to the curves of the skull, one part is usually sawn through before another. It is advisable, therefore, to test the depth of the groove from time to time with the flat end of a probe or with a toothpick, so as to be sure of the progress made; and unless it is done intentionally, the region of the sinuses and the course of the middle meningeal artery should be avoided. If larger portions of bone have to be removed, so as to expose a considerable surface of the cortex, a trephine fixed to a carpenter's brace, or to a surgical engine, may be employed. When the first opening has been made, it can be enlarged in any required direction, either by means of Hey's saws or by the gouge-forceps.

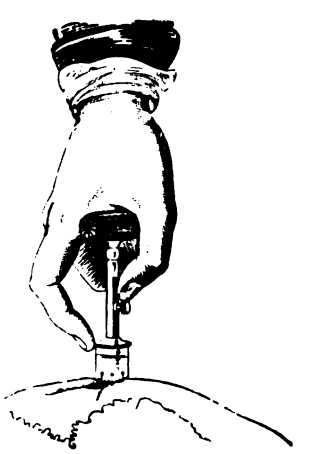


Fig. 294.

The bone removed should be kept warm in a weak solution of carbolic acid and replaced, either bodily or after being broken up. In many instances, where the periosteum has been laid over it again and the dura mater is not sunken down, the vitality of the bones has been retained, and it has contracted adhesions to the parts near.

When it is a mere question of removing splinters, and the dura mater has not been cut, the flaps are replaced and the wound sewn up (after being thoroughly washed out with corrosive sublimate solution) except at its most

dependent part. Generally a drainage-tube is unnecessary, unless there has been a great deal of bruising, or the cavity of an abscess has been laid open, so that union by the first intention is improbable. If the dura mater is incised to any extent, it should be thrown downward in a flap, as recommended by Horsley; rather smaller than the opening in the bone, in order that, when replaced, it may be readily fixed by sutures, and thus help to maintain the cerebral pressure until union is complete, and avoid the risk of hernia cerebri.

[Prof. Senn, in common with most German surgeons, prefers the chisel and mallet to the trephine.]

### Cerebral Localization.

An elaborate description of the relation between the surface of the scalp and the cerebral convolutions would be out of place in a work of this kind; a full account may be found in the papers by Reid, Hare, Anderson, Makins, and others; still, a few general statements are almost necessary. It must be premised that anything like mathematical accuracy is utterly out of the question; to say nothing of the differences at different ages and in different types, the same rules often will not hold good in more than a general way for the two sides of the same head.

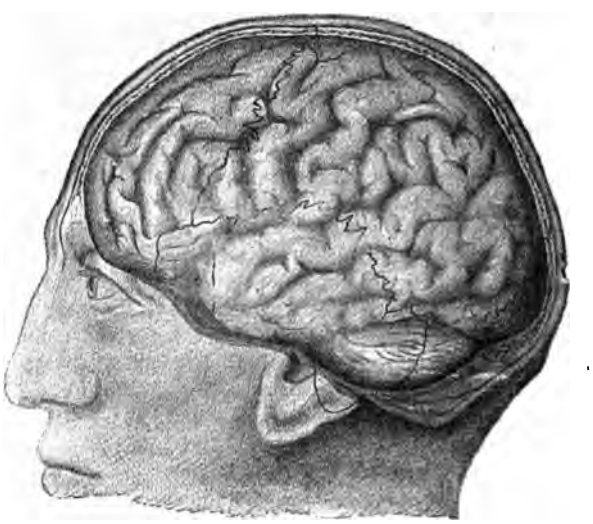


Fig. 295.—The Relation of the Sutures and the Chief Points on the Skull to the Cerebral Convolutions. The vertical depth of the temporo-sphenoidal lobe is unusually great for an adult.

The fixed points of chief value are the glabella, the inion, the external angle of the orbit, the external auditory meatus, and the parietal eminence. The last mentioned, which at first sight appears to be particularly vague, is really of very great value, as it bears a certain relation to the general development of the skull and is nearly always in close correspondence with the supramarginal gyrus.

The most important boundary lines for the brain are the fissures of Sylvius and Rolando and the tentorium. Of these the last is easily marked by the superior curved line; the two former are more difficult.

The upper end of the fissure of Rolando is most easily defined by the measurement originally given by Thane, half an inch behind the mid-point between the glabella and the inion, supposing, of course, the fissure were continued to the great longitudinal division.

The lower does not really admit of definition. The easiest

by means of Wilson's cyrtometer. A strip of metal (graduated according to Hare's measurements to suit skulls of different shapes) is carried along the sagittal suture from the glabella to the inion; on this glides a metal rod, about three and a half inches long, forming with the sagittal band a fixed angle of 67°. This when placed in position corresponds approximately in length and direction to the fissure of Rolando as measured upon the scalp. The angle is more open in some brains than in others; possibly 67° is slightly more than the average, which other measurements place at 65°, but it is sufficiently near for practical purposes; nine times out of ten, it will allow a required point to be exposed with a trephine an inch and a quarter in diameter.

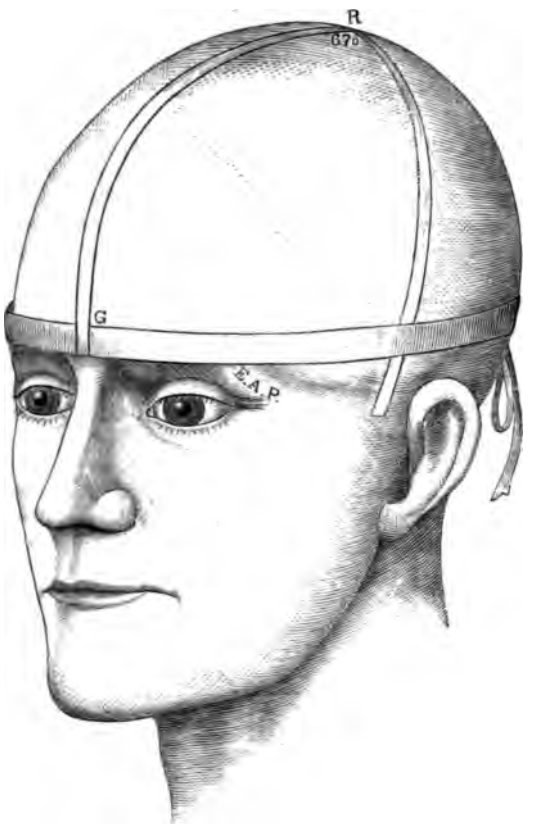



FIG. 296.—Wilson's Cyrtometer *in situ*. G, glabella; E A P, external angular process; R, fissure of Rolando—its position and direction marked by the lateral strip of metal. (*After Bramwell.*)

The direction of the fissure of Sylvius is equally difficult. Hare takes a base line from the external angle of the orbit to the inion; this passes rather above the external auditory meatus. The beginning of the fissure of Sylvius lies on this rather more than an inch from its commencement, and runs directly upward and backward from it to the parietal eminence. Practically the same line may be obtained by starting from the middle of the outer border of the orbit (the external canthus or the sharp margin of bone that lies beneath it) and ending at the same point. The point of bifurcation is approximately three-eighths of the distance from the edge of the orbit.

# CHAPTER VIII.

## *INJURIES AND DISEASES OF THE BACK.*

## SECTION I.—MALFORMATIONS.

### Spina Bifida.

In the strict sense of the term spina bifida refers to the condition of the spinal column; but it is usually understood to mean a congenital tumor projecting through the ununited laminæ of the vertebræ, and formed of the cord or its membranes, or of both together.

It is nearly always on the back; cases are reported in which the protrusion has taken place on the anterior aspect of the vertebræ through the bodies, but they are very rare, and are generally associated with other deformities. Three-fourths of the whole number are found in the lumbo-sacral region, where the medullary groove is open latest; of the rest, the majority occur in the neck, but they may protrude through any part, from the occiput downward, or may even involve the whole length of the column.

**Symptoms and Diagnosis.**—Spina bifida usually occurs in the form of a rounded, sessile (sometimes pedunculated) tumor, projecting in the middle line of the body, over the spine, with which it is closely connected. It may be of any size, larger even than the child's head. In some instances the skin over it is natural; in most it is reddened, devoid of hair, and exceedingly thin; in a few it is vascular, like a nævus, and velvety, so far at least as the most prominent part is concerned, and occasionally there is a great growth of hair all round it, converging in a spiral fashion toward the central point. The swelling may be perfectly uniform in shape, or there may be a longitudinal groove running vertically downward over it in the middle line, beginning and ending with a little pit-like depression, and sometimes in addition two lateral grooves can be made out, wide apart at the centre, but converging at their extremities toward the same small pits.

The sac is very often translucent, and the nerve cords can be traced by transmitted light running obliquely across it. Fluctuation is distinct, and when the neck is wide the wave can be felt even at the anterior fontanelle. The tension varies according to the quantity of fluid present, increasing if the child cries or if the pelvis is allowed to hang down. Some of the contents can often be reduced by steadily compressing the sac, so that the edges of the cleft can be felt; but the proceeding is a dangerous one, likely to cause convulsions.

Complications are often present. Talipes, paraplegia, and atony of the external sphincter are due, in all probability, to the condition of the sacral plexus, and point to the fact that the spinal cord, or the nerves coming from it, are involved in the sac; meningocele, ectopia of the viscera, and other malformations result from a similar arrest of development in other parts of the body.

The diagnosis rarely presents any difficulty. The position of the tumor, its congenital origin, and its varying tension are sufficient to distinguish it from everything but nævus. Every now and then, however, other forms of congenital tumor closely resembling it are met with in this region. False spina bifida is the most deceptive. Strictly speaking, it is a single cyst in communication with the spinal canal, but not with the membranes or the cord, and probably it originates from the sac of a true spina bifida, the neck of which has become occluded. But congenital lipomata, and even myo-lipomata, are known to occur, springing from the interior of the spinal canal and spreading out, either between the arches, or through an opening left by their imperfect growth, until they form large masses sessile upon

the backbone. The true multilocular sacro-coccygeal tumors are, as a rule, in connection with a part of the spinal column which is not the seat of spina bifida.

**Pathology.**—There are three chief varieties of spina bifida, of which the second is by far the most common.

(*a*) *Meningocele.*—Protrusion of the membranes only; the skin covering it may be thinned and reddened, but in other respects it is perfectly natural. The cord lies in its proper situation, and there are no nerves in the sac.

(*b*) *Meningomyelocele.*—Protrusion of the cord with its nerves and membranes. The skin around the neck of the tumor is natural; over the most prominent part it is replaced by a thin, vascular layer, which shows no trace of corium, hairs, or sweat glands, and the line of transition is sharply marked. This layer is the flattened out spinal cord itself, which, in the most typical examples, leaves the spinal canal at the upper angle of the cleft, passes backward across the sac until it meets and fuses with its posterior wall, and then leaving it after a variable distance, regains the canal below. In some instances the cord is structurally complete, and although the normal arrangement of white and gray substance is somewhat inter-

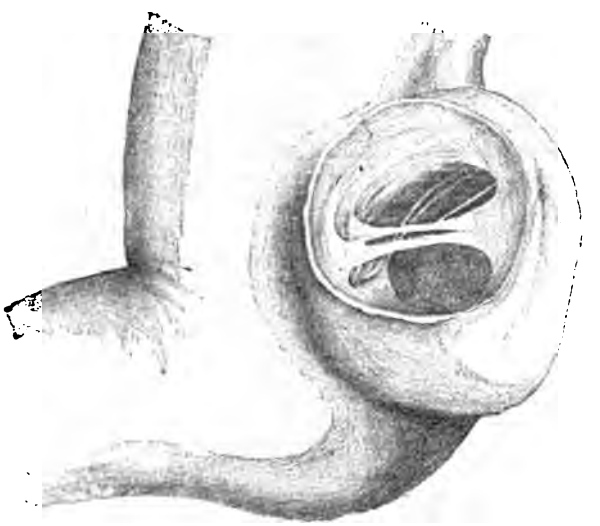


FIG. 297.—Meningomyelocele Laid Open. The centre is marked by a pit leading down to the spinal canal. Below this is a trifid groove. The whole of the posterior surface is composed of flattened-out spinal cord, the line at which the true skin stops being clearly marked off. In the interior the ligamentum denticulatum and some of the roots are stretched across from back to front.

fered with, the central canal can still be recognized in transverse microscopic sections. In others the cord itself is flattened out from in front; the posterior fissure has never been closed, and the central canal forms the median groove already mentioned, ending in a pit above and below, where it resumes its normal situation. Finally, in a few the pressure of the fluid in front of the cord has been so great that the anterior columns are separated, and between them there is a vascular, velvety protrusion of pia mater. The position of the nerves is, of course, considerably modified: the anterior roots spring from the concavity of the roof of the sac near the middle line; the posterior ones arise from it further down the sides, with between them an enormously elongated ligamentum denticulatum. Sooner or later the roots fuse together to form a trunk, which, running partly in the wall of the sac, partly across its interior, passes between the margins of the cleft into the spinal canal, in order to gain its proper intervertebral foramen. The dura mater lies on the posterior surface of the bodies of the vertebræ, and can be traced into the wall of the sac as far as the covering of the true skin, never further. The sac, in other words, is an immensely distended subarachnoid space.

(*c*) *Syringocele.*—The central canal of the spinal cord is dilated, forming the cavity of the sac; the posterior wall is formed of skin, as a rule, with the expanded posterior columns of the cord, and perhaps the dura mater.

In all of these there is a defect in the arches and laminæ of the vertebræ (spina bifida); much rarer deformities are sometimes met with, chiefly in association with syringocele, itself very rare; defective development of the bodies of the vertebræ, for example, so that they are either cleft vertically, or that one-half is wanting; growth of a bony process backward through the substance of the spinal cord and even complete division of the spinal cord into two for more or less of its length.

From the fact that in sacral spina bifida the cord is found still occupying the sacral region (the nerves coming off horizontally without forming a cauda equina), while at birth it has normally receded far up the lumbar part, it is clear this deformity originates at the very earliest period, when the spinal cord and the vertebral column are practically of the same length. The defect is in the formation of the medullary canal.

Spinal meningocele is the most simple. In this the neural canal has closed,

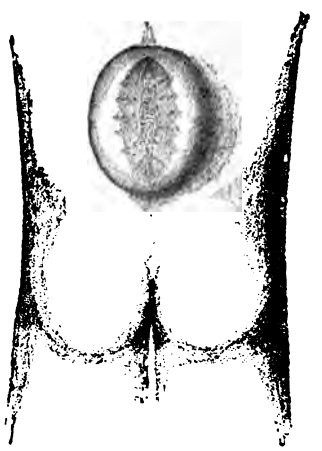


FIG. 298.—Meningomyelocele, showing the vascular Pia Mater in the centre, the flattened cord on either side, and, above, the pit leading to the central canal (diagrammatic).

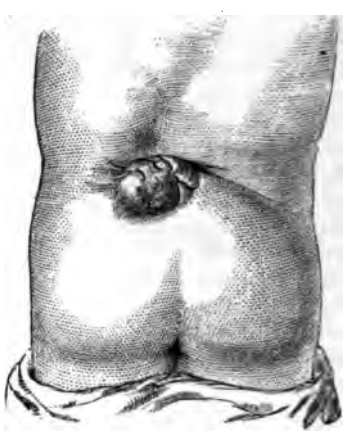


FIG. 299.—Cured Spina Bifida, taken from a man æt. 26.

so that the cord itself is well formed; but the mesoblastic elements which should grow around it and enclose it on the dorsal surface are imperfectly developed; the bony laminæ, the muscles and the substance of the true skin are deficient in various degrees (according to Recklinghausen, the dura mater is wanting in this as well as in the other forms); and the protrusion is due to passive distention; fluid is secreted in the sac under the pressure of the blood, and the wall is too thin and weak to resist.

In meningomyelocele the fluid collects in the subarachnoid space in front of the cord; if the neural canal is closed already, the cord itself is gradually flattened from before backward and pushed out from the cleft, until it joins and fuses with the epidermic covering developed from the epiblast, the sole trace of all the structures that should protect the spinal cord behind. In this case a transverse section through the posterior wall of the sac reveals, on microscopic examination, the flattened out central canal, and there is no median groove or pit. In the other form the defect occurs at an earlier period still, before the medullary groove is closed to form the cord and the layer of elementary nerve tissue is first flattened out, then becomes convex backward, until at length it projects as the covering

fine-walled cyst. In the most extreme cases the anterior columns are so far separated from each other by the pressure that a strip of pia mater, that which should line the bottom of the anterior fissure, forms a longitudinal velvety band on the most convex portion of the sac.

The other malformations are due to the fluid collecting in the central canal, and to inequality of growth of various parts of the vertebral column. The bifurcation of the spinal cord is probably an indication of the enormous power of reproduction and repair possessed by the embryo at the earliest period. If the neural canal is prevented from closing into a tube, each half may in some instances be capable at that time of life of forming one for itself.

**Treatment.**—If the protrusion is small, covered over with healthy skin, and not inclined to enlarge, it should be carefully protected with cotton-wool and collodion in sufficient thickness to form a fairly rigid covering, or with a gutta-percha cap. There is a possibility of its gradually shrinking up. In most cases, however, the sac is increasing rapidly and threatens to give way sooner or later if left to itself. If the skin is already ulcerated or the wall is actually broken, it should be dusted over with iodoform and carefully packed with iodoform gauze or salicylic wool, in the hope that meningitis will not follow, and that the wound will cicatrize under the protection.

The only treatment that has met with any success is the injection of Morton's fluid: this consists of iodine gr. x, pot. iod. gr. xxx and glycerine ℥j. A puncture is made with a fine trocar and cannula through the healthy skin near the bottom of the sac, and a certain quantity of the fluid, not more than half, allowed to escape. Then half a drachm to two drachms of the solution is injected, taking care that none escapes by the side in the cellular tissue, and the puncture sealed with collodion. The opening may be made valvular to prevent the contents draining away. Afterward the sac must be carefully packed in cotton-wool with a slight amount of pressure, and the child kept as quiet as possible, so that the injection may not diffuse itself too rapidly. In successful cases the sac soon begins to diminish in size, and at length shrivels up into a rounded solid excrescence; but very often several injections are required, and it not unfrequently happens that after a while the skin becomes red and the opening begins to leak, or the child is attacked by convulsions and meningitis sets in.*

Excision of the sac has been practiced successfully in cases of simple meningocele, but as it is impossible to prove that the spinal cord is not involved in the sac, this operation should very rarely be undertaken.

The prognosis is rarely favorable. Even in simple cases the child is seldom well nourished; in the more severe ones—when, for example, there is a large thin-walled sac—it is nearly always small and puny; and in many there is clear evidence from the first of paralysis or other nerve lesions. Growth, especially of the lower limbs, is usually stunted; areas of anæsthesia persist; some of the muscles of the lower extremity continue in a state of spastic rigidity, so as to limit the action of the joints; and handling the cicatrix left may in some instances give rise to evidence of nerve irritation, passage of urine, defecation, and sexual emissions.

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[*Prof. Brainard, the originator of this method of treatment of spina bifida, used the Lugol solution. The solution used by him consisted of iodini .03, potass. iodidi .10, aquæ destillat c.c. 33.

The rules laid down by Brainard for performing the operation were: First, to make the puncture subcutaneously in the sound skin, by the side of the tumor; secondly, to draw off no more serum than the quantity of fluid about to be injected; thirdly, to evacuate the contents of the sac, if symptoms of irritation supervene, and to replace them immediately with distilled water. The patient should lie on his side or face after the operation, and if there be much heat, warm, evaporating lotions should be applied to the part on head. As soon as the tumor becomes flaccid it should be covered with collodion, or supported by pressure continued for some weeks after the cure has been effected; and lastly, the injection should be repeated as often as may be necessary, care being taken that the previous irritation has completely subsided.

The operation is performed with a very delicate [illegible] being accurately closed with adhesive strips.]

## Congenital Sacral Tumors.

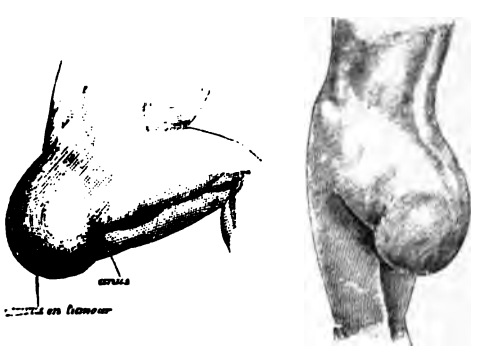
A great variety of congenital tumors is met with in connection with the sacro-coccygeal region, and the origin of many is still involved in doubt.

(*a*) *Spina bifida* (true and false) may occur on the back of the sacrum. Its diagnosis and treatment have already been discussed.

(*b*) *Congenital lipomata and myo-lipomata* are also met with, springing from the interior of the spinal canal and protruding through an opening in its wall. Similar growths, due in all probability to the accidental transference of tissue germs at a very early period of embryonic life, are also met with higher up in the column. When small their diagnosis from spina bifida is almost impossible without a puncture. They have been excised with success.

(*c*) *Congenital sacral tumor*, in the limited sense of the term, is applied to a mass, often of enormous size, developed in the region of the coccyx, in front, displacing it; or behind; or hanging from it by a neck. It is made up of cysts of all sizes, from that of a pea to a horse-chestnut, communicating more or less freely with each other, and filled with a thick gelatinous material. When small the epithelium lining them is columnar, resting upon flatter cubical cells. In between is a variable amount of fibrous tissue with fat, hyaline cartilage, and sometimes even bone. It seems probable that this growth originates from Luschka's gland, which in its turn (according to Bland Sutton) is the rudiment of the post-anal gut of the embryo. Excision is the only line of treatment possible, but very careful examination is necessary, as not unfrequently the growth extends much further up the pelvis or the spinal canal than would be imagined from external appearances.

(*d*) *Dermoid cysts*, containing the ordinary mixture of sebaceous material, hair, etc., are not uncommon. Sometimes they communicate with the rectum or bladder, and occasionally they are of very large size, extending long distances up the pelvis. As Bland Sutton has pointed out, there is an especial tendency to the production of these growths in those localities in which fusion of the germinal layers takes place in the embryo.



Figs. 300 and 301.—Congenital Coccygeal Tumors.

(*e*) Finally, *attached fœtuses* of all grades of development may be met with. There may be merely a shapeless, formless mass of skin, containing fibrous tissue, bone, and fat, all mixed up together; or a well-formed limb; or even larger portions still. Excision is the only treatment practicable, flaps being formed from the part removed for the purpose of covering in the stump; but full examination of the connections should be made in every case, as it is impossible to say how far growths of this kind may be incorporated with the bearer of them.

## SECTION II.—INJURIES.

### INJURIES OF THE BACK.

Injuries of the back, like those of the head, derive much of their importance rom the danger to which the great nerve centres are exposed. Independently of his, the structure of the spinal column is so complex, its position as the axis of upport for the trunk and the chief base for the movements of the body so important, that no injury, however slight, can be inflicted upon it without producing a serious, and often a widely felt, effect.

#### Sprains and Wrenches.

These are very common, especially in the flexible parts, the cervical and lumbar regions; sometimes they are chiefly muscular, as in cases of overwork—lifting heavy weights, for example—or in sudden awkward twists; sometimes, when due to external violence, they involve the fibrous textures, the ligaments, fasciæ, and synovial membranes as well, the muscles either being caught unawares by the unexpected jerk or being overpowered. The worst of all occur in railway collisions, when suddenly and without any warning, before a single muscle can contract, the body is wrenched and twisted, or thrown with overpowering force from one side of the carriage to the other, until every muscle or ligament that has an attachment to the spine is strained or hurt.

For various reasons, the spinal cord itself escapes more frequently than might be expected; it lies in the central axis, so that in all movements it occupies neutral ground; it is separated by some distance from the walls; around it there is a water-bed, probably always filled with fluid; and in the lumbar region, where the range of movement is as great, perhaps greater, than anywhere else, its place is aken by the cauda equina.

The extent of injury in these cases is very variable. No structure is always xempt, but probably the muscles and fibrous tissue are the greatest sufferers. The rmer may be thrown into a state of cramp; they may be torn or wrenched away om the bone; there may be hemorrhage into the sheath that invests them; this ay be torn and the muscular substance forced through the rent like a hernia; or, specially in the neck, where the long slender slips lie closely packed together side y side, there may be a real dislocation. The latter may be still more damaged; he broad sheets that extend on either side of the spine may be overstretched, or he loose cellular tissue that fills up the irregular spaces around and between the ones crushed, and bruised; or, what is much more serious, some of the ligaments at connect the vertebræ may be strained until they yield. This is especially ngerous, not only from the proximity of the membranes and the cord and the sk of their being injured at the same time, but from the danger of hemorrhage d inflammation. A certain amount of extravasation must always occur, causing ill-defined swelling and tenderness, and giving rise to pain and inconvenience en any attempt at movement is made; but if the posterior ligaments, especially ligamenta subflava, are torn, the bleeding may be very severe, owing to the e of the veins that surround them, and the blood may pour down the spinal al.

In other cases, the spinal nerves are hurt, stretched possibly as they pass out ough the foramina, or compressed by extravasation, so that the effects are red to distant parts of the body. Even the bones and joints do not escape, for, ugh it is rarely possible to prove the existence of definite injury at the time, it ertain that inflammation may break out in them afterward.

The complications that follow these injuries depend largely upon the state of the patient's health. Stiff neck, lumbago, and chronic rheumatism occur in some, particularly after middle life; synovitis and osteo-arthritis, leaving the spine rigid, ankylosed, and perhaps distorted, occur in others; caries is exceedingly common, especially in children and young adults; and, what is still more serious, if the ligaments have been torn and hemorrhage has taken place in the vertebral canal, inflammation of the membranes or of the cord itself may follow. In most cases this is very insidious; softening sets in slowly, and steadily grows worse and worse; in a few rare instances it is acute, suppuration commencing externally in the broken-down blood-clot or in the joints, and spreading through a rent in the membranes or along the lymphatics, until the dura matral sheath is involved. This is not so frequent as in the skull, owing to the wide separation between the dura mater and periosteum, and the lower vascularity of the former in the spinal canal; but it has proved fatal in many cases of latent fracture.

Sprains of the back have acquired a peculiar significance from their frequency in railway collisions, and attempts have been made to distinguish them, when they occur under these conditions, from others. Except, however, for their severity, and for the fact that they are always associated with a very grave degree of shock which is certainly not without influence upon the subsequent progress, there is no reason for such a step.

charged through an abscess: more frequently death occurs either instantaneously from sudden displacement, or gradually from myelitis.

(*b*) *Those Due to Injury of the Spinal Cord or Nerves.*—In most cases, even when no displacement is apparent, the cord is completely crushed and the power of conduction and reflex action lost. The former never returns; a clean division of the spinal cord might possibly be repaired, even in man; hemisection certainly may; but the injury sustained in accidents of this kind is much too grave. The latter, if the patient survives, returns to some extent as the shock wears off, and may in some cases become exaggerated. Recently Bowlby has pointed out that, so far as men are concerned, there is a material difference in this respect between the behavior of the superficial and deep reflexes; the former may return, whether the cord is crushed completely or not; the latter never do unless some part still remains unhurt. If this is substantiated it must become a factor of very great importance both as regards prognosis and treatment.

Another sign of great significance has been pointed out by Thorburn; when the violence is extreme, the roots of the spinal nerves are crushed and torn as badly as the cord itself, and the area of anæsthesia corresponds anatomically with the seat of the lesion. If, however, the force is not so great, the nerve-roots lying by the side of the cord may escape, even though the cord itself is crushed, and thus give rise to an apparent discrepancy, especially in the lower dorsal and lumbar regions. The prognosis in the former case is certainly much worse, and if ever surgical interference is justifiable, it can only be in the case of the latter.

If the injury is not so severe, as for instance happens occasionally in the lumbar region, motion is always more affected than sensation, and although perfect recovery is rare, a certain amount of repair may take place, leaving more or less anæsthesia and spastic rigidity. When due to hemorrhage the symptoms, as a rule, begin gradually; there is an interval of a few minutes, or even of some hours; and, as Horsley has pointed out in the case of tumors pressing upon the spinal cord, the paralysis of motion spreads from above downward, the anæsthesia in the opposite direction. In the slighter cases, when the blood is absorbed, the symptoms begin to disappear again, following the reverse order; but perfect recovery is uncommon, and not unfrequently after temporary improvement red softening sets in.

Occasionally the symptoms occur in such a peculiar manner that it is difficult to believe they can be due merely to suspension of the activity of the cord. Limited hyperæsthesia, for example, is very common; sometimes it becomes general, and is so intense that the slightest touch causes agony; muscular wasting is the rule; but every now and then cases are met with in which it is so rapid that it is difficult to believe that it is only the result of disuse. The most striking examples, however, are sloughing of the skin, and inflammation of the urinary organs. Both of these are common results of fracture of the spine, and in nearly every case admit of a local explanation; but occasionally they are so intense, so rapid, and attended, with such an amount of congestion and extravasation that it has been suggested they must be the result of irritation of the cord. Symmetrical patches of skin on the inner sides of the thighs, for example, where there can be no pressure, have sloughed and become gangrenous in a few days; suppurative nephritis has set in within forty-eight hours; and weeks after the accident the most intense cystitis has suddenly broken out and proved fatal without the slightest evidence of any local cause. Moreover, in one or two cases, these lesions have occurred when there has been no fracture at all, but merely hemorrhage into the gray substance of the cord and red softening.

The nature of the symptoms and the prognosis depend upon the seat of injury; loss of sensation, for example, extending as high as the umbilicus, points to injury of the seventh dorsal vertebra; if it extends to the ensiform cartilage, above the sixth. The superficial origin of the nerves only corresponds to the point of exit from the canal in a very few instances; and, as Reid has shown, vari

nensely with regard to the spinous processes. The first dorsal, for instance, hich passes out below the first dorsal vertebra and helps to form the ulnar, is arly always destroyed in fracture of the seventh cervical; the second, third, and arth lumbar are at their origin opposite the eleventh dorsal; while the whole of he sacral plexus corresponds roughly to the upper border of the first lumbar. Further, owing to the softening of the cord that follows injuries, it generally appens that a day or two after the accident the paralysis and loss of motion extend upward toward the head.

### *Injuries of the Upper Cervical Vertebræ.*

Dislocation of the head from the atlas is very rare, but can be produced by a violent blow upon the occiput while the patient is stooping forward. Fracture of the atlas is nearly as rare; dislocation from the axis with fracture of the odontoid process is the common form. The check ligaments are stronger than the bone, so that this gives way either at the base, or more frequently below, through the body of the axis. Dislocation without fracture is seldom met with, but may occur in children, owing to the smaller size of the odontoid process, and, possibly in adults when the injury is the result of violent rotation, the check ligaments, as it were, being torn across in detail.

Injuries of this character, are, of course, usually fatal at once; the lower end of the medulla and the upper part of the cord are destroyed by the odontoid process being driven in. In a very few instances, however, life has been prolonged, owing to the large size of the ring of the atlas and the thickness and toughness of the attachment of the dura mater to the margin of the foramen magnum. Sometimes, in these cases, sudden displacement has taken place after hours, and even after days.

Fracture immediately below this is equally fatal, owing to the phrenic nerve. e main root comes out with the fourth cervical. If the centre is destroyed th is practically instantaneous, as diaphragmatic and intercostal respiration are h interrupted.

### *Injuries of the Lower Cervical Vertebræ.*

The most common seat of fracture as well as dislocation lies between the fifth vical and the first dorsal; and, as a rule, the cord is completely crushed. tion and sensation are entirely lost in the trunk aud lower part of the body. a few cases there is a want of symmetry at first; the paralysis may extend one even two nerves higher on one side than on the other; but as softening sets in s soon disappears. Immediately above the paralyzed region there is a zone of hyperæsthesia; when this is immediate it can only be explained by the mechanical itation of the nerves above the seat of injury; more frequently it does not make appearance for some hours, not until the circulation in the parts round the jured area has become more active. Owing to the shock, reflex action is at st entirely suspended; the cutaneous reflexes give no response; irritation at e neck of the bladder, or at the anus has no effect; the function of the part of e cord below is, for the time being, practically abolished; the vaso-motor nerves e paralyzed, the blood-pressure falls, the secretion of urine is diminished, the art beats very feebly, and the pulse is rapid, small, and soft.

In injuries through this region the fibres of the sympathetic that supply the lator pupillæ must be paralyzed, so that dilatation of the pupil cannot take ace. It is, however, difficult to estimate, as it occurs on both sides, not on one ly, as when the brachial plexus is torn away from the cord, and the degree of ntraction is not very marked.

The actual distribution of paralysis and anæsthesia depends naturally upon e seat of the lesion, but there is considerable difficulty in ascertaining the exact ntre and nerve-root for individual muscles, and without this, of course, perfect

localization is impossible. [The following table, founded almost entirely upon clinical data, is taken from Thorburn, doubtful muscles being excluded:—

| | |
|---|---|
| Supraspinatus, | Fourth cervical nerve. |
| Teres minor (?), | |
| Biceps, | Fifth cervical nerve. |
| Brachialis anticus, | |
| Deltoid, | |
| Supinator longus | |
| Supinator brevis (?), | |
| Subscapularis, | Sixth cervical nerve. |
| Pronators, | |
| Teres major, | |
| Latissimus dorsi, | |
| Pectoralis major, | |
| Triceps, | |
| Serratus magnus, | |
| Extensors of the wrist, | Seventh cervical nerve. |
| Flexors of the wrist, | Eighth cervical nerve. |
| Interossei, | First dorsal nerve. |
| Other intrinsic muscles of the hand, | |

—*From Thorburn.*]

These, of course, as Thorburn points out, are only the chief points of origin, minor connections not being regarded. Thus, if the injury is above the sixth cervical, the elbow is flexed and supinated, the arm abducted, and the wrist and fingers motionless—a most characteristic attitude; if below this, abduction and supination are better performed, and a certain degeee of extension and adduction is possible, but there is still no power over the lower joints.

The level of the anæsthesia is not so difficult; the fifth root, the first of the series supplying the fore limb, is distributed to the region of the deltoid and the outer aspect of the arm and forearm as far as the base of the thumb; the eighth and first dorsal supply the inner side of the arm, forearm, hand, and little finger; the sixth and seventh are distributed to the intervening spaces on the anterior and posterior surfaces.

Respiration is embarrassed from the first. All the muscles that raise the ribs and help to enlarge the thorax are paralyzed; only the diaphragm is left. Inspiration is carried on with difficulty; instead of the chest expanding when the diaphragm contracts, so that at the end of the act it is distended in all directions, it collapses and sinks in, and the work of the diaphragm is in great measure lost. Expiration is worse still; at the commencement, when the chest ought to be dilated to its utmost, ready to recoil from the elasticity of its walls as soon as the muscles relax, it is already contracted, and every expiratory muscle is paralyzed. The only forces left are the elasticity of the partially-distended lungs and the weight of the abdominal viscera which have been pushed downward and forward. Coughing is impossible; full expansion of the lungs cannot take place; the bronchi become plugged with mucus, and the blood gradually stagnates at the lower and back part of the lobes until, the respiration growing worse and worse each moment, and the action of the heart becoming feebler, hypostatic congestion or pneumonia sets in. Generally this proves fatal in the course of a few days.

As the shock passes off, the character of the symptoms begins to change. The loss of motion and sensation remains unaltered, or possibly extends a short distance higher up, but the superficial reflexes gradually return. If their recovery is long delayed, or if, having once returned, they begin to fail again, the prognosis is very grave; in one case it points to injury so serious that it may prove fatal before reaction can set in; in the other to progressive softening of the cord.

The first sign is the recovery of the circulation: the heart begins to beat more firmly, the skin becomes warm, and the state of extreme prostration passes off. In

fracture through this region, however, strange variations are not uncommon. In some cases, the pulse becomes abnormally full, slow, and deliberate; in others the temperature falls immediately after the accident, and, in spite of the shock passing off, continues to drop until in one instance it is said to have reached 80° 6′ F. More frequently it rises rapidly; I have known it to ascend from 93° F. to 109° F. within thirty-six hours; and higher temperatures than this, persisting and sometimes even rising after death, have been recorded on many occasions. It is impossible to avoid comparing this with the results of curare-poisoning, but it cannot be said to explain in any way. As has been shown by Hutchinson, high temperatures are always associated with vigorous action of the heart and full, throbbing pulse.

The secretion of urine is but little altered; the quantity is scanty at first, owing to the general fall in the blood pressure; but as the shock passes off it increases again. Sometimes there is hæmaturia without any direct injury to the lumbar region, possibly from extreme distention of the capillaries; and it is said that the urine, as secreted by the kidney, is not unfrequently alkaline in reaction.

Micturition is always affected. At first there is complete retention; the lumbar portion of the spinal cord, has, for the time being, completely lost its power, and the urine simply accumulates in the bladder. If this is not relieved the result is merely a question of relative pressure; the bladder becomes more and more distended, until, if left sufficiently long, its muscle passes into a state of atony, the elastic resistance of the sphincter gives way, and the urine flows out drop by drop, leaving the bladder as full as it can be.

If the patient survive, the subsequent condition is not always the same. Sometimes, as the cord regains its power, micturition takes place involuntarily at regular intervals: the bladder becomes distended, a drop of urine flows into the neck, the stimulus passes up to the lumbar centre in the cord, and as the influence of the brain is not there to strengthen the sphincter, the muscles of the bladder contract and empty the cavity more or less completely. This appears to be the rule in the lower animals, but such perfect recovery of function is rarely met with in man; either from atony of the wall of the bladder (arising from its over-distention), or from the spinal centre never regaining its full power of reflex action, a catheter has generally to be passed at regular intervals, or the bladder must be emptied by pressure over the pubes.

Cystitis is exceedingly common; in some few cases it may be caused, like bed-sores, by irritation of the cord—extreme congestion, followed by intense inflammation, suppurating and sloughing setting in without any local cause, and attacking kidneys, ureters, and bladder together—but such must be very rare; in by far the majority it is due to the extreme difficulty of taking proper precautions for such a length of time. There is everything to favor its occurrence; the bladder and urethra are absolutely insensitive; their walls, deprived of all opportunity of working, are badly nourished and therefore prone to inflammation; the cavity is never properly and naturally emptied; the mucus which is secreted and which lines the urethra is not washed out, but remains as a tenacious alkaline coating; the constant introduction of a catheter, even when it is perfectly clean, acts as an irritant; the amount of mucus increases; and the acidity of the urine diminishes until every condition that favors the growth of the specific urea ferment is present. If, in such circumstances, it finds its way in, whether by means of the catheter (which is usually the case) or along the mucus of the urethra, or through the kidney, decomposition immediately begins, the urine becomes ammoniacal, every drop as it falls into the bladder becomes an intense irritant, and the most severe cystitis, so bad as to cause sloughing of the mucous membrane, or perivesical suppuration, is sure to follow. In a large number of the cases in which the patient escapes hypostatic congestion, this proves fatal, either directly or through the secondary inflammation, suppurative pyelo-nephritis.

Priapism is common in fractures above the mid-dorsal region; sometimes it is immediate; more frequently reflex, not beginning until a catheter is passed or

the bladder becomes distended. It is rarely marked in degree; and, if the patient survives, usually passes off of itself; occasionally, however, it is extreme and it may be followed by extravasation into the erectile tissue.

As a rule in these fractures the alimentary canal suffers very little; obstinate vomiting has occasionally been noticed in injuries of the cervical region, and tympanites may occur, possibly from absence of the natural support to the intestines after the muscles of the abdominal wall are paralyzed. Wherever the fracture takes place constipation is the rule, so long as the motions are solid; the peristaltic action of the intestine is in abeyance for some time, then it gradually recovers, and at long intervals passes on the contents into the rectum; the sphincter is completely paralyzed, and as soon as the lower part of the bowel is reached evacuation takes place involuntarily. Liquid motions, as when there is diarrhœa, flow away continuously without control. In those instances in which the patients recover the bowels usually act once or twice a week, the motions being very copious and solid; and after a time the patient becomes aware, from the feeling of headache, or oppression, or from flushing of the face, when an evacuation is going to take place.

In by far the majority, fracture of the lower cervical spine is fatal within the first four days; few last out the week; a very small number is recorded as having survived for longer periods. Still it is possible for life to be prolonged for months and even for years, in spite of paralysis of the trunk and legs, and in one or two instances of the arms as well. The nutrition of the paralyzed part is very feeble; bed-sores are liable to form upon the sacrum, the ischial tuberosities, and the trochanters. If they occur within the first few hours, they may be the direct result of irritation of the cord, but much more often they do not make their appearance until three or four days have passed, and are due entirely to local causes. The body lies absolutely motionless, hour after hour, pressing upon the same points, without intermission of any kind or sense of discomfort; the skin becomes red; the epidermis is detached, the cutis exposed, and a slough soon forms, spreading perhaps until the bone beneath becomes necrosed, or even the spinal canal is opened. If the parts are allowed to become wet or sodden from fæces or urine, this is sure to occur, and the inflammation is very likely to end fatally.

All over the paralyzed part the skin becomes harsh and branny, covered with desquamating scales; the rounded outline of the limb disappears, the bones become prominent, the muscles waste and become hard and unyielding, and the limbs are either fixed in a condition of permanent flexion, or are subject to constant twitchings, which may be so violent as to shake the whole body. As may be imagined, the health soon begins to fail, though in fractures through the dorsal region the nutrition of the rest of the body is sometimes maintained surprisingly well; and even if the patient escapes the immediate consequences of the injury, he is very likely to succumb to the first trivial accident with which he meets, even a mere cold, especially if it attacks the lungs.

### *Injuries of the Dorsal Region.*

The symptoms of fracture below the first dorsal vertebra are practically the same, making allowance for the difference in position and number of the muscles that are paralyzed. Owing to the small size of the canal, the cord is generally crushed completely; there is the same risk of cystitis and bed-sores; priapism, however, does not occur unless the injury is high up; the temperature is rarely phenomenal; and respiration is not so much interfered with. The extent to which this takes place depends upon the number of intercostals paralyzed. Temporary recovery is not unfrequent, but death follows sooner or later from bladder trouble, from bed-sores, exhaustion, or from degeneration and softening further up the cord.

### *Injuries of the Lumbar Region.*

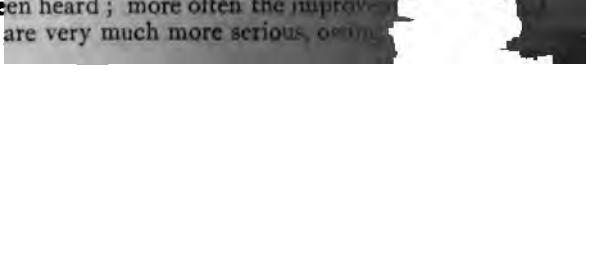
The lower the injury the better the prognosis: the shock is not so great, the spiratory muscles escape, and owing to the flexibility and toughness of the nerves at form the cauda equina, the loss of motion and sensation in the parts below is ften incomplete. In fractures through the last dorsal or first lumbar vertebra, e centre that governs the act of micturition is destroyed, and the effect on the ladder is the same as if all the nerves going to it were cut across. At first there s retention of urine, and, unless relief is given, overflow, just as when the cervical ord is hurt; but in a short time the muscles begin to degenerate and contract; hey become hard and lose their elasticity; the capacity of the bladder diminishes ntil its cavity is almost obliterated; and a condition of true incontinence is produced, the urine flowing out from the urethra as it passes down the ureters. The effect on defecation is not so marked, as the action of the intestine is to a much greater extent independent of the spinal cord.

When the fracture occurs below the second lumbar the symptoms are often obscure. The cord itself, of course, escapes, being above the seat of injury; so may the long flexible roots of the cauda equina, which slip to one side or the other out of the way; and there may be either no nervous symptoms of any kind, or partial loss of motion and sensation, with violent pain shooting down the limbs, owing to some of the nerves being crushed or torn by the broken fragments of bone. If the fourth sacral is injured, there is true incontinence, as when the micturition centre is destroyed. These cases of latent fracture not unfrequently escape diagnosis; there is no crepitus or undue mobility, nor of necessity is there any deformity; merely local pain and tenderness, and a great sense of weakness and insecurity when an attempt is made to stand or move. The prognosis of course, much more favorable; but, as in fracture of the spine elsewhere, there is always e risk of chronic inflammation setting in and extending along the membranes til the cord becomes affected.

**Treatment**.—In many cases the cord is completely crushed at once, beyond hope of recovery; sometimes the injury is made very much worse by the ill-ised efforts of assistants. If therefore there is the barest suspicion of such an dent, the patient should merely be laid perfectly straight upon his back on level and and not raised or moved until there is some one to superintend his being ed upon a stretcher. A water or air-cushion, circular or horseshoe-shaped for ice, is essential for the sacrum, and is better than a water-bed; and the mattress l draw-sheets must be arranged so that the bed-pan may be used without dis-bing the patient. The outer clothes and boots may be removed while the patient on the stretcher; the others should be left until he is lifted on to the bed and rything is ready for a complete examination.

Active treatment is impossible in the majority of instances; if, however, defi-e displacement can be made out, if there is a distinct irregularity in the spines, a projection where there ought to be a hollow, and if the patient's condition mits of it, reduction should certainly be attempted, and as soon as possible; lay only increases the risk of hemorrhage and softening of the cord from pres-e; but, particularly in the cervical region, it should be explained to the friends t the proceedings may prove immediately fatal.

In unilateral dislocations of the neck, when one articular process only is dis-ced, and when the accident is the result of sudden twist, reduction is often nded with conspicuous success. The patient should be cautiously placed under anæsthetic, so as to relax the muscles; the head, which already inclines towa d opposite shoulder, bent over as far as can be to disengage the processes; ar n rotated so as to carry the under side forward. Slow extension with rotati succeeded even without an anæsthetic, the patient being seated and t erator standing behind, grasping the head while the shoulder[illegible] es a sudden snap has been heard; more often the improve[illegible]



Bilateral dislocations are very much more serious, o[illegible]

of the body; but even here a sufficient degree of success has occurred to warrant the proceeding. Hüter recommends the same method as in the unilateral form, one side being reduced first, and then the other, on the ground that extension when all the ligaments are so much torn would expose the cord to undue risk; and in one case out of three he succeeded in saving life. Ashhurst, however, gives particulars of several in which permanent improvement followed gentle extension combined with rotation, and in one instance with pressure upon the displaced body from the interior of the pharynx. When the displacement is not reduced, the result is almost sure to be fatal within the week. It must always be remembered in manipulating that the upper fragment is displaced forward, and that if it is carried ever so little further in this direction the cord must be crushed. As soon as the displacement is rectified, the head must be fixed by weight-extension, and the arch of the neck supported from below, either by a sand-bag (others being used to prevent lateral bending) or a collar made from softened mill-board, or, better, from sheets of absorbent cotton dipped in thin plaster-cream.

Extension under anæsthetics, combined with pressure, has also been successful in injuries of the lower dorsal and lumbar regions; but the displacement is seldom completely rectified, owing to the presence of fracture and to the locking of the articular processes. Crepitus has been felt on several occasions while it was being done. Weight-extension should be applied to the legs before the patient comes round, in order to prevent any recurrence.

Where there are no nerve symptoms the trunk may be encased at once in plaster-of-Paris, as the best method for ensuring rest and guarding against injury to the cord; and the same plan has been adopted with great benefit in injuries of the lumbar region in which the displacement has been rectified. Berkeley Hill has done it within thirty hours of the accident; in most of the other cases two to four days have been allowed to elapse.

In the earlier cases the vertical position was tried, the patient either being supported under the arms, or, better, laid upon a table swinging upon a central axis like a toilet glass, and then carefully slung up from Sayre's tripod. In the more recent ones the jacket has been applied with the patient lying down. A bed is prepared with folded blankets and a mackintosh, and two bandages are laid upon it, crossing at right angles to mark the ground plan: one must be long enough to reach from the occiput to within an inch of the trochanters; the other must be one-fourth more than the girth of the patient's chest. On these are placed, first, a many-tailed bandage made of coarse house-flannel to go on the outside of all; then a layer of crinoline bandages, three-fold thick, soaked in mucilage and plaster (the proportions are generally an ounce of mucilage to a pound of plaster). The upper strips must be laid in position first, and each must overlap the one above it at least two-thirds. Then, over this in a similar manner, a second and a third layer, the ends of the strips being prevented from sticking to those above and below by laying a piece of ordinary bandage over these down each side. Over all is laid a sheet of absorbent wool, especially thick on either side of the spine, so as to protect the processes as far as possible; and a small water or air-cushion may be fixed opposite the sacrum, so that when the jacket is set its contents may be let out, and may be withdrawn without disturbing the rest. If the jacket is sufficiently long to come well over the gluteal region, and clasp the crests of the ilia, it will hold the trunk firmly enough.

The patient must be lifted up from either side, carried over the foot of the bed while extension is still being kept up, and laid gently down in the exact position that has been prepared for him; and then commencing from below, each strip must be carefully folded round, crossed over, and smoothed down as rapidly as possible.

In a very large proportion of cases all that can be done is to protect the patient from the various complications that may set in. The effect of the pressure on the back must be avoided as far as can be by water-cushions and pillows, and of elephant plaster. The skin must be kept as dry as possible, and wi

n opportunity, should be sponged over with spirit to harden it; but care must aken that the shoulders are not rolled over first, to dry that part of the back, l the hips afterward. Even the position of the extremities must be carefully ched, and the weight of the bed-clothes prevented from pressing them down, sores may form upon the external malleoli and elsewhere. The bladder must be ptied by means of a catheter three times a day; of course the greatest gentle- s must be used, especially as the part is absolutely insensitive; but this is not ough, the catheter must be of the softest description, and must be kept in a ution of carbolic acid; it is not enough to dip it in before using. If there is the st sign of cystitis, gr. xv of benzoate of ammonia should be given three times a y, to try and keep the urine acid; the bladder should be very carefully washed t with Condy's fluid, boracic acid, or a very dilute acid solution of corrosive blimate; and a grain of sulphate of quinine dissolved in an ounce of water may injected afterward and left in. Phosphatic calculi of enormous size have rmed in the bladder after fracture of the spine. The bowels are better left one, at first, at any rate; the amount of food the patient takes is generally very all, and the inconvenience of constipation is not to be compared with the risk movement and the danger to the skin. Care, however, should be taken that e anus and the parts around it are kept dry. If the bowels do not act of them- lves after a few days, an enema may be given.

Pain shooting down the nerves is sometimes relieved by continuous extension; e hyperæsthesia that sets in on the second day and occasionally extends over the n-paralyzed portion of the trunk is more difficult to treat. Probably it is the sult of hyperæmia of the cord, and points to the commencement of red soften- g or myelitis. Iodide of potash in large doses has been recommended, and eches have been applied with advantage when the injury was in the lumbar region, that the bites would not afterward be pressed upon; but the prognosis when this ts in is very grave.

In cases of fracture by indirect violence the operation of trephining offers tle or no hope. It is probable that in the majority of cases the cord is only bjected to momentary compression, but yet it is so reduced to pulp that recovery function very rarely follows. If it were possible to diagnose the persistence of mpression and to relieve it by operation, the condition would be no better and e probability of recovery not in the least greater. This has been confirmed by tual trial in a sufficient number of instances; in fractures of this description the jury to the nerve structures is either so slight that an operation of such a nature not justifiable, or so severe that it could do no good.

In fractures by direct violence, on the other hand, the question is altogether ferent. The lamina or a spine may be driven in with just sufficient violence to mpress the cord without destroying it; and if anything of the kind is suspected, operation should certainly be performed at once. It has proved its merit. ll more is this the case with cauda equina. The nerves that compose it may be mpressed by displaced bone or by cicatricial tissue, and although they possess a wer of adapting themselves altogether unknown in the spinal cord, there are its even to this; and if improvement does not take place, or if in a few weeks egins to flag, it is open to argument whether it would not be better to expose seat of injury and, if possible, release them.

### INJURIES OF THE SPINAL CORD.

The spinal cord may be injured by itself without the vertebral column being t. It may be bruised from a violent blow upon the back, or torn from forced ding; it may be compressed from hemorrhage, from bone that has been ven in, or from inflammatory products thrown out by the meninges; it may be shaken by concussion that its activity is partially suspended, or it may be nded by stabs or punctures between the arches of the vertebræ. The symp- ms are essentially the same as when it is crushed in fractures of the spine; and

the same sequelæ, softening and inflammation, may set in, but they differ considerably in their extent and in the time of their occurrence.

*Contusion of the Spinal Cord.—Hæmatomyelia.*—Hemorrhage into the substance of the cord is nearly always the result of forced flexion, and occurs naturally in the region in which fracture by indirect violence is most common. Sometimes the similarity of origin is shown by their occurring together, but independently of each other. It is possible, however, that it may be caused by direct violence also. The hemorrhage nearly always lies in the gray substance of the cord, because this is the softest and the most vascular part; and it may occupy an indefinite length. The effect is immediate, becoming intensified later as the hemorrhage extends. Motion and sensation are lost over a corresponding area; reflex action is suspended for a time, but rarely so completely as when the cord is crushed; and then later, as the circulation around the injured area becomes more active, hyperæsthesia sets in; motor disturbances are rare.

The subsequent course depends chiefly upon the degree of the primary injury. The extravasated blood may be in great measure absorbed, leaving a certain degree of anæsthesia, with paralysis or spastic rigidity of the muscles, corresponding to the part of the cord that has been destroyed; or, on the other hand, red softening and ascending myelitis may follow, the paralysis extend higher, bed-sores and cystitis set in, and, if the injury is in the cervical region, phenomenal temperatures, just as when there is a fracture. According to Thorburn it is probable that cases of hemorrhage into the cord are much more common than is usually suspected.

*Wounds of the spinal cord* are rare in civil practice, but they may be produced by stabs, the weapon passing between the arches of the vertebræ, possibly notching or incising them as it does so; or by gunshot injuries. The symptoms in either case depend upon the seat and the extent of the injury, and only differ from those of crushing of the spinal cord in fractures by their proneness to inflammation and suppuration. There are several authentic cases on record in which men have recovered completely after symptoms that pointed to at least partial division of the cord; so that it is probable that, though it may not be so perfect as it is in animals, a certain amount of repair may take place, whether this consists in actual reunion of the divided fibres, or in a re-arrangement of conduction in the cord.

*Compression.*—This is much more rare; it may be caused by a lamina driven in, though when this occurs the delicate nervous tissue is almost sure to be utterly crushed; or by hemorrhage, either inside the theca or between it and the bones (it is impossible to distinguish one from the other); or later it may result from inflammation, as in Pott's disease. If due to bone the symptoms are immediate; if to hemorrhage, there is a distinct interval before they commence, and they progress from below upward, affecting the leg first, and then the trunk, until the respiratory muscles are involved. The loss of motion is more marked than that of sensation, but it is rarely so definite as in contusion; pain along the course of the nerves, hyperæsthesia extending round the trunk, and muscular tremors are more frequent. In many instances the blood is absorbed again and the symptoms subside; occasionally it accumulates to such an extent as to prove fatal, either from its pressure or from secondary softening and degeneration.

*Concussion.*—The position of the spinal cord, surrounded by a water-bed and suspended by the nerves and the ligamentum denticulatum in the centre of a flexible column of bone, which nowhere presents any large surface exposed to injury, is such that concussion, by itself, must be very unusual. If the term is used in the same sense as in speaking of the brain: it can only be caused by direct violence; the symptoms must be immediate; there must be no gross lesion, merely suspension of activity for a time, and then, after a few minutes or some hours, gradual recovery. Practically, therefore, it occurs under the same conditions as contusion, and can only be distinguished from it by the symptoms being general, not confined to any one portion of the spinal cord, and by their passing off within a few hours. Such cases do occur, though it very rarely happens that there is an opportunity of proving them. Gull (Guy's Hospital Reports, 1858) mentions one of peculiar

nterest: a man, 40 years of age, fell on his back from a moderate height; im-mediately after the accident there was partial paralysis of the upper and lower extremities with collapse, but no insensibility. Later in the day, as reaction set in, and the skin became warm again, the paralysis gradually disappeared. The next morning symptoms of injury to the cervical portion of the cord came on; paralysis of upper and lower extremities; anæsthesia; priapism; tympanites; high temperature; and paralysis of the respiratory muscles followed. He died at the end of the third day. *Post-mortem* the membranes of the cord and the cord itself appeared entirely uninjured; so that the earlier symptoms can only have been due to concussion: outside the theca, caused by a fracture through the body of the fourth cervical vertebra, was a large extravasation of blood which had gradually extended down the canal and compressed the cord. There was slight displace-ment of the body of the fractured vertebra, but not sufficient to press upon the membranes.

Afterward, when the immediate symptoms have disappeared, hyperæmia may set in, as in concussion of the brain. If there is no contusion this may be merely transient, and under proper treatment subside without leaving behind any serious result; but if the part is not kept at rest, or if there is severe contusion, it may increase, and either run on to inflammation or lead to softening and degeneration.

Railway accidents are not unfrequently followed by a peculiar train of ymptoms which have been grouped together under a name, "railway spine," stly stigmatized by Page as absurd.

The symptoms do not set in immediately and are not those of any gross lesion f the cord, such as contusion or inflammation. As a rule they do not appear for ree or four days; then, after lasting some time, they either begin to subside or adily grow worse. The chief difficulty is to distinguish them from locomotor axy and chronic meningo-myelitis, both of which may undoubtedly follow injuries the back. If, however, sufficient attention is paid to objective symptoms, to e distribution of areas of anæsthesia, for example, and the electric reactions of uscles, it can usually be surmounted.

Railway accidents are always accompanied by an extreme degree of shock. ometimes this takes the ordinary form of profound collapse from the first; more equently there is a peculiar phase of unconsciousness associated with excitement; ain is not felt; an enormous amount of energy, often strangely misdirected, is isplayed; and then suddenly, some time later, the patient, as it were, wakes up id is entirely unable to account for himself, or what he has done, or explain how e came to be where he is. This is generally followed by violent reaction, the ore intense perhaps for being so long postponed. The temperature falls; the ulse becomes small and feeble; the face is pale; the forehead covered with cold erspiration; there is retention of urine; often the secretion is scanty; in short, e patient lies in a state of complete prostration.

This may end in various ways.

Occasionally, but fortunately not very often, it grows worse and worse; the tient becomes more feeble, and without being able to assign any definite reason r it, or find any gross lesion, death ensues after a few weeks or months, just as metimes happens after a severe mental shock.

More frequently there is a certain amount of improvement for a time, but ot perfect recovery. The extreme depression passes off, but the patient remains eak and feeble, unable to control himself or to exercise deliberate judgment, ith mental capacity and bodily vigor alike impaired. The symptoms are of the ost varied character. Some, such as palpitation, flushing, alternate sensation of eat and cold, and menorrhagia, may be accounted for by the disorderly working f the vasomotor system; others, like sleeplessness, dreaming, headache (often osterior), irritability of temper, emotional display, noises in the ears, and failure f sight, are due to interference with the blood supply of the brain and the organs f special sense. Dyspepsia is always present and makes the other symptoms orse. The breath is foul; the bowels are constipated; the bodily strength fails;

the patient becomes worn and emaciated; the cerebral symptoms grow more pronounced, and at last he becomes utterly broken down in health, feeble in mind as well as body, and aged before his time.

This is not in any way peculiar to railway accidents. It may be induced by injuries of all kinds, especially those who from heredity or for other reasons are in any way predisposed to the occurrence of nervous disorders. It is not uncommon for example, after severe and prolonged mental trouble; it may even follow a single shock; and I have met with minor degrees of it in several of those who were exposed to the earthquake in the Riviera, and in one person after a dynamite explosion. Occasionally it persists for the rest of life; as a rule, it passes away by degrees; and, as Page has clearly shown, even when there is no suspicion of fraud, there is often rapid improvement as soon as the irritating question of compensation is settled. Too little is known about the working of the central nervous system to hazard a suggestion as to what really happens in such cases; but there can be no doubt that the brain is involved at least as much as the cord, and very possibly a great deal more.

In another class the symptoms resemble those ordinarily grouped together as hysterical. There may be epileptiform attacks from time to time, with insanity, melancholia, or suicidal impulse. Anæsthesia and hyperæsthesia may occur, affecting the special nerves as well as those of ordinary sensation. There may be, for instance, contraction of the field of vision, achromatopsia, or hyperæsthesia at various points; one-half of the body may be anæsthetic, or one limb, the line of limitation being circular, not corresponding to the anatomical distribution of the nerves; and occasionally hysterogenic points, pressure upon which causes epileptiform spasms, are associated with these. In other instances muscular paralysis, affecting physiological groups rather than anatomical ones, or spasmodic contraction is present, the electric reaction remaining unaltered. Retention of urine and aphonia are very common; and numerous other symptoms are met with from time to time—pains in the joints, for example, of the most excruciating character, without any objective sign, dysphagia, torticollis, closure of the jaws, etc.

Thorburn has ingeniously attempted to explain these results by a comparison with what takes place by "suggestion" in hypnotic sleep. There is certainly to all appearance a very close resemblance between the condition of unconscious excitement that so often occurs after these accidents, and some phases of hypnotism; and there is nothing impossible in the idea that the violent shock and emotion at the moment are capable of producing either this condition or one closely similar to it. Now Charcot has shown that in hypnotized persons light blows are often followed by paralysis and anæsthesia, and it is quite possible that trivial injuries in railway accidents, or even suggestions of them, when there is this condition of profound mental shock, are capable of doing the same.

If in either of these groups of cases there is in addition a severe sprain of the muscles or ligaments of the neck and back, so that every movement is attended with pain, the difficulty of proving that the whole mischief is limited to external structures, and that the spinal cord is not involved as well, may be imagined. The local symptoms, the stiffness, rigidity, and pain, grow worse and worse as time goes on. If the hypnotic state continues, each suggests some further trouble, and it is almost impossible to distinguish between the real and the functional disorder. The desire to get well is often not genuine, even when it is present, and it is impossible to obtain any assistance from the patient. If there is even a suspicion of chronic inflammation of the spinal cord, it is a serious matter to propose active measures. And thus it comes about that time passes by; the muscles become more rigid from disuse; the extravasated blood becomes organized; adhesions are formed in all directions; and it ends in leaving a permanently crippled condition.

The diagnosis from chronic inflammation of the spinal cord rests chiefly upon the absence of definite local signs. Stiffness and rigidity of the back are not leading characteristics of chronic meningitis. When this sets in there are

her symptoms, usually of an unmistakable character: there is pain along the line of certain nerves; or anæsthesia and hyperæsthesia of definite regions; rtial groups of muscles are wasted or paralyzed; the electric reactions are normal; the cutaneous reflexes are enfeebled or lost; in short, there is definite idence of injury to nerves or centres in the cord, such as does not occur in ains of the vertebral column alone, however severe the mental depression and illy weakness may be.

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## SECTION III.—DISEASES OF THE BACK.

### DISEASES OF THE SPINAL COLUMN.

#### Osteitis.

Inflammation of the vertebræ is nearly always tubercular, in children almost ithout exception, although it is not impossible that the immediate starting point f the disease is some slight injury causing an extravasation of blood into the substance of the cancellous tissue. In exceptional cases it may be due to syphilis (perhaps more frequently than is suspected, in the case of adults), and late in life to rheumatism, osteo-arthritis, and osteitis deformans.

#### Tubercular Osteitis.

This is essentially a disease of childhood, although it may occur at any period of life. Sometimes it is excited by injury and affects one part of the spine only; more rarely several vertebræ are involved together. Like tubercular osteitis elsewhere, it nearly always begins in the cancellous tissue, where growth is most rapid nd the blood supply most abundant. The upper or under surface of the bodies f the anterior border is the favorite seat; the spinous and transverse processes re never involved at the first, although later they become welded together as the nflammation extends to them; and the articular processes only when, as in disease f the atlas and axis, synovitis precedes osteitis.

The most common situation is at the junction of the lumbar and dorsal gions; here the bodies are large, and strains are felt most severely. The cervil vertebræ enjoy much greater immunity, and the two highest, in children at ast, the greatest of all. There is some reason to think that disease of the atlas d axis is proportionately more common in adults.

Usually the intervertebral discs are destroyed with the bones between which ey lie, the granulation tissue eating into them and causing their gradual absorpn. Sometimes they disappear at a very early period, as if the force of the ease was spent on them rather than on the bodies; very rarely they persist, as en the vertebræ are absorbed by the pressure of an aneurysm.

**Pathology.**—This does not present any special feature. The disease begins rarefying osteitis, the bone becoming softer, more open and vascular, and the ne corpuscles undergoing fatty degeneration. According to the intensity and mber of bacilli on the one hand, and the strength and resisting power of the ues on the other, resolution, caseation, or liquefaction follows.

In the most fortunate everything is restored; the bacilli are killed or reved by the tissues and recovery is complete. In others not so good the ocess steadily advances without any caseation (caries sicca or fungosa) until solid structure of the spine is replaced by masses of soft granulation tissue, ich yield and give way beneath the weight of the trunk. In others again the ntre slowly degenerates, caseates, and becomes liquid, forming a so-called eous abscess, filled with serum, mixed with broken-down particles of bone an

cheesy debris. Sometimes, when the inflammation is severe, fair-sized sequestra are found as well (caries necrotica). Even then recovery is possible, with more or less deformity. Part of the debris is absorbed, the rest undergoes calcification; the vertebræ fall together, and ankylosis occurs (Fig. 304). On the other hand, however, the caseous focus may extend, grow larger and larger, until somewhere it approaches the surface, breaks, and unless due precautions are taken, becomes infected with pyogenic germs as well.

Disease of the upper two cervical vertebræ nearly always commences as synovitis and extends from the articulation to the bone beneath, spreading along the most vascular lines, and therefore, if it involves the axis, separating the odontoid process from the body.

The deformity depends upon the amount of destruction. If the caries is superficial, involving only the anterior surface of the body, and if repair begins at once, it may be entirely wanting. If the bodies are softened or destroyed, even if only part of one, the spine above sinks forward, the spinous processes project

FIG. 304.—Ankylosis of Dorsal Vertebræ, with great Deformity Consequent on Caries of the Bodies.

FIG. 305.—Tubercular Osteitis with Caseation under the Anterior Ligament and in the Bodies of the Vertebræ. A triangular sequestrum has been driven back so as to compress the spinal cord.

backward, and compensatory curves in the opposite direction are developed above and below. This is most distinct in the dorsal region; the lower cervical rarely becomes convex backward, only a little thickening is perceptible, and the lower lumbar practically cannot. Disease between the axis and atlas is peculiar again in this; for, owing to the shape of the articulation on the former, the latter when the ligaments are softened by inflammation, or the odontoid process is detached from the base on which it rests, slips bodily forward, carrying the head with it, so that when the patient is looked at from one side it appears as if the head were placed in front of the spine.

The effect of this displacement (when it is below the third cervical vertebra) on the diameter of the spinal canal is exceedingly slight; often it is actually enlarged; exceptionally a wedge-shaped portion is driven backward (Fig. 305) into the substance of the cord. When the upper two, however, are concerned, the atlas slides forward, and the antero-posterior measurement opposite the odontoid process may be reduced to less than half an inch. This, if it is effected gradually, is not incompatible with life, and the odontoid process may even

lying down, it may not be felt at all. It is a rough but a sure test for the absence of spinal caries to stand a child on the seat of a chair and tell it to jump down; if it comes down readily and fairly on its feet from a height of only a few inches, osteitis is out of the question.

*Tenderness on percussion* is very important, especially in adults; a smart tap with the finger on the tip of the spinous processes will generally show whether there is any inflammation. Not unfrequently the skin covering the same region is hyperæsthetic, especially to temperature, owing, in all probability, to the distribution of the posterior divisions of the spinal nerves, for the same thing may be noticed over the insertions of strained and overworked muscles.

*Muscular rigidity* is highly characteristic: every movement of the segment of the back for some distance above and below the seat of mischief is avoided with the greatest care. If the cervical spine is involved, the whole trunk is turned around instead of the head when the patient wishes to look to one side, and it is done with the utmost deliberation. If it is the back, and the child is told to pick up anything from the floor, the hips and knees are bent, the head is thrown back, and the spine kept absolutely rigid. Sometimes it voluntarily goes on hands and knees. For the same reason the walk is very peculiar, entirely different from the natural mobile gait, and wry-neck and other distortions are not unfrequently present. Where children are concerned *the weakness of the back* must be judged of by their actions. They cease to play and run about; they wish to be left alone quietly; and if they must stand, they try to support the weight of the head and shoulders by resting their hands upon the furniture or even upon their knees, propping themselves up in a crouching attitude. With adults it is more easy, as they can explain the peculiar difficulty they experience in holding themselves upright.

Early diagnosis is often a matter of real difficulty, particularly in the case of children. In many cases it is advisable to act upon the safe side and confine them to bed for a few days. Wry-neck, for example, arising from strains, inflamed glands, cold, or reflex irritation, may simulate the beginning of cervical caries very closely; but, as a rule, a few days' rest is sufficient to make the distinction clear, and can do no harm. The danger is that the earlier symptoms may be overlooked and regarded merely as growing pains or stomach-ache.

With young adults, particularly girls, hysteria is the chief difficulty; and it must always be recollected that even when some of the symptoms are transparently exaggerated, there may be real disease behind. The projection of the lower cervical vertebræ is a frequent source of alarm, especially as it is sometimes greatly increased by muscular weakness or from some habitual faulty attitude. Fortunately, the symptoms generally exhibit such discrepancies that, if not at the first examination, at least after two or three, the existence of caries may be negatived without fear.

The diagnosis is much easier when *deformity* is present; but the disease may be far advanced before it makes its appearance; and, as just mentioned, care must be taken not to mistake natural projections for pathological ones (see *Angular Curvature*).

Caseation and liquefaction may occur, even though deformity is never present, and no case of spinal disease should be allowed to pass without investigating all the ordinary situations.

*Retro-pharyngeal abscess* usually first attracts attention by the difficulty it causes in breathing and swallowing. Generally it lies rather to one side of the middle line and is accompanied by an ill-defined swelling near the angle of the jaw; in some cases fluctuation can be felt across from one point to the other. Left to itself, it may burst into the back of the pharynx (it has been known to cause suffocation from entering the larynx); or work its way into the mediastinum; or point on the side of the neck. Large fragments of the atlas and axis have been discharged through the opening in the pharynx in many instances.

*Dorsal or lumbar abscess* forms a soft fluctuating swelling [illegible] of the erector spinæ. Not unfrequently it is divided in two b[illegible]

and often it is only the superficial part of a much larger cavity in the psoas and can be considerably reduced in size by steady pressure. The diagnosis usually presents no difficulty; but it must be distinguished from subcutaneous abscesses, hæmatomata, suppuration in connection with the ribs, empyema, nephritic and perinephritic abscesses, pyonephrosis, hydronephrosis, hydatids, and soft elastic sarcomata originating in connection with the bones or the kidney.

*Psoas abscess*, when the abdomen is thin, as in a child, can be felt under the linea semilunaris as a soft, ill-defined swelling by the side of the spine. The hip is flexed, the thigh adducted, and not unfrequently there is severe pain along some of the branches of the lumbar plexus. In other cases it remains latent and even unsuspected throughout. There is no limit to its size, and its shape presents infinite variety. It may work its way out under Poupart's ligament behind the vessels and point to their inner side in the adductor region; or the fascia may give way in other parts and offshoots spread into the iliacus, down the opposite psoas, into the pelvis (coming out through the perineum or the sacro-sciatic foramen), or down the thigh on its outer side near the tensor fasciæ femoris. It has even been known to extend into the inguinal canal and down into the leg.

True psoas abscess may occur independently of bone disease, after injury (though it is not unlikely that many of these cases are really due to superficial caries); or from inflammation of the hip joint, or of the bones of the pelvis. Other abscesses are met with in the same region in connection with the lymphatic glands, the cæcum, kidney, and even the pleura; and sometimes pelvic cellulitis works its way upward as well. In addition it must be distinguished from femoral hernia, bursæ, or cysts, such as develop occasionally in connection with the hip joint, and soft, rapidly growing tumors springing from the bone, lymphatic glands, or cellular tissues. Its chief diagnostic feature is the ease with which it can be made to disappear by gentle, steady pressure when the patient is lying down, and the gradual way in which it fills again. Sometimes the neck is so wide that there is a distinct impulse on coughing, and not unfrequently fluctuation can be made out between the intra and extra-abdominal parts.

*Spinal paralysis*, like suppuration, may begin at any period, although naturally it is more common in the later stages of the disease. Loss of motion always precedes that of sensation, and may be nearly complete without the latter being seriously impaired. The gait becomes shuffling; the movements of one or more of the limbs are awkward; and the loss of power becomes more and more evident, with a certain degree of numbness, until at length complete paraplegia follows. So long as the cord is merely compressed the patient may retain power over the rectum and bladder, but this too is not unfrequently lost in the later stages. When myelitis sets in there is often severe pain along the course of the spinal nerves, with spasmodic muscular contraction; the skin becomes dry and branny; all power of the sphincters is lost; the limbs are wasted, the joints generally speaking flexed, and the muscles rigid and not unfrequently thrown from time to time into violent spasmodic contractions from the uncontrolled reflex irritability of the spinal cord. Occasionally the inflammation suddenly becomes acute and extends upward, with symptoms of high fever, to the meninges of the brain.

In disease of the cervical spine respiration may be seriously endangered either from displacement forward of the atlas and cranium upon the axis (Fig. 306), or when the disease is lower down from gradual flattening of the cervical curve, owing to the softening of the ligaments. Under these circumstances any sudden movement of the head, either forward or backward, or even lying in the supine position without a support beneath the arch of the cervical spine, may cause immedia[te] asphyxia.

The peculiar carriage of the head, [which] is held perfectly rigid in [a] position (generally poking forward [or] occasionally dragge[d] back); the pain along the course [of] especially the gre[at] occipital; the spasmodic contracti[on] when any pressure is made on [the]

early signs of disease of the upper cervical vertebræ. Many of these may occur together under other circumstances, when, for example, the muscles of the neck have been strained, or when the cellular tissue or the lymphatic glands lying between them are inflamed; and it may be almost impossible at first to make a certain diagnosis.

FIG. 306.—Separation of the Odontoid Process by Caries, Ankylosis of the Detached Part to the Atlas, and Reduction of the Spinal Canal to a Narrow Chink.

**Treatment.**—The general principles have been described already under the head of tubercular osteitis. With very few exceptions local removal of the diseased portion is out of the question; all that can be done is to improve the general health and subdue the local inflammation, in the hope that the tissues may be able to cope successfully with the disorder.

Rest is the first consideration. In most cases it is advisable to confine the patient, for a time, at least, to the recumbent position, on a well-made hair mattress with sand-bags as splints. In disease of the upper cervical vertebræ it is absolutely essential, a bag being placed on either side, coming well down against the shoulder, and a third smaller one under the arch of the spine. If the patient's circumstances are favorable, this may be kept up for many months without the least deterioration of health; indeed, distinct improvement is not uncommon, especially when the pain has previously been severe. Later, when the acute symptoms have subsided and the tenderness on pressure has disappeared, the back may be encased in some kind of splint, and the patient allowed very gradually to begin to move about.

Unfortunately, this is not practicable in the majority of cases, although an attempt should always be made to secure a prolonged rest at the commencement. Even with a splint, however, very great success may be obtained, if only the patient can be kept quiet, supplied with good food and fresh air, and made to lie upon a reclining chair the greater part of the day; but with children, particularly in the poorer classes, in whom this disease is so common, the difficulty is almost insuperable.

The splints in common use are made of plaster-of-Paris (Sayre's jacket), poroplastic felt, or metal. Of these the first is by far the cheapest, and is especially useful for children, in whom the weight of the body is light and the bony prominences well defined. For older patients, and particularly women, it is not nearly so suitable; the weight of plaster is too great, and the fit is not so accurate or close. The disadvantages are that it cannot be used where there are suppurating sinuses, and that it cannot be taken off. A well-made jacket will always last three months and sometimes six, although for the sake of the development of the thorax it is never advisable to leave it on so long; but the objection, to many people, is quite insuperable.

Poroplastic felt is more expensive and does not fit so well; but it is much lighter; it can be taken on or off with ease; and if very great strength is required at any spot, strips of metal can be fastened to it. Its chief use is in the later stages, when only general support is required; and it is best to obtain it roughly fitted to the shape of the trunk already, so that there is no difficulty in moulding it. Moist or dry heat may be used to render it flexible for the time; but if any parts are required permanently soft, as, for example, over the breasts, they must either be left so in the manufacture or the resin dissolved out afterward. It is fastened in front with straps and buckles, one side overlapping the other considerably; and in taking it off it must be rotated through a quarter circle first, so that the thorax may slip out sideways.

Metal supports are very much more expensive, requiring skilled labor.

constant attention afterward; but particularly in the case of adults, and of short but stout and heavy people, they are the only ones of real service. They consist of a metal girdle which can be buckled round the pelvis; two uprights, one on each side, carrying crutches, partly for the support of the shoulders, partly to prevent the drooping forward of the upper part of the trunk, and to give a point of fixed resistance for straps; and of a single or double support in the middle line

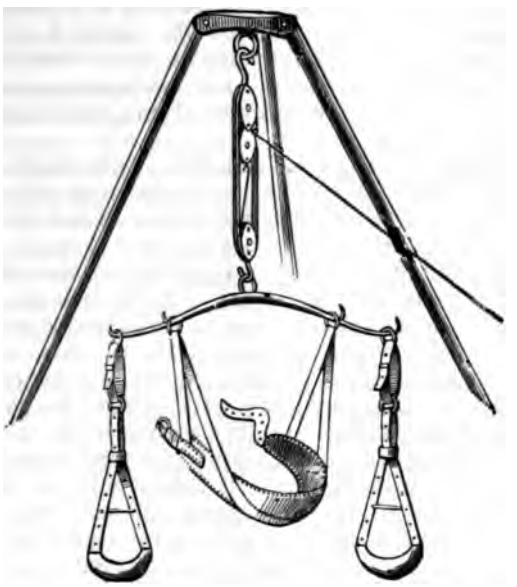

FIG. 307.—Apparatus for Applying Sayre's Jacket; Consisting of Tripod, Pulleys, and Suspension Supports for Arms and Chin.

behind, fitted to the spine, and capable of being made to press either forward or to one side, by means of a ratchet arrangement. In many cases it carries lateral plates as well, so that when the patient stands upright and the body sinks down against them, a large part of the weight is transmitted directly to the pelvis. These do not, of course, secure the same amount of rest as a well-made plaster splint, but special modifications suited to individual cases may be devised much more easily.

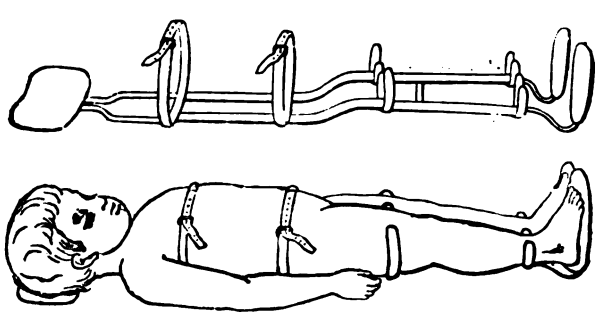

FIG. 308.—Double Thomas's Splint for Caries of the Neck.

Sayre's jacket is applied to the patient while in the vertical position, slung from the head and shoulders (Fig. 307). A specially made collar is fitted under the chin and the occiput, and two well-padded straps under the arms. These are fastened at a proper height and at a proper distance from each other to a horizontal cross-bar, which in its turn is suspended in the centre of a tripod stand, and is so arranged that it can be raised or lowered at once without any jerk. The patient is

first fitted with a sleeveless merino vest, fastened on top of the shoulders and coming down well over the crests of the ilia. Except in children with very flaccid and prominent abdomens, a pad of suitable size should be slipped in from below between the vest and the stomach, and withdrawn when the jacket is dry; and in females similar smaller ones may be used for the breasts. Any special bony prominence should be protected by surrounding it with a ring-pad outside the vest, to be left permanently. The bandages are made of very coarse crinoline muslin torn into strips about four inches wide; and the plaster is well rubbed into the meshes as they are rolled. If it is not perfectly fresh it should be re-baked, or a little alum may be added to the water. The bandages are placed under water, standing on one end, one at a time, a second being put in as the first is taken out.

As soon as everything is ready the patient is gently raised until only the toes rest upon the ground; there is no object in swinging clear, and sometimes it causes considerable alarm. As a rule, if there was any pain before, it disappears at once, and if the straps are properly arranged most patients describe themselves as perfectly comfortable. The effect is not to straighten out the curve, that would be most undesirable, but to fit the jacket to the trunk while in its best position, with the thorax expanded. When the patient is lowered the ribs and the scapulæ sink down and are fixed by the weight of the body against the inner wall. The first bandage is applied round the hips; and then successive turns are carried round the abdomen and thorax, without making any reverses, until the body is encased sufficiently strongly, from the armpits to three-quarters of an inch below the iliac crests. An assistant in the meanwhile smooths the surface down, and if there are any inequalities rubs a small quantity of plaster in. In adults, where great strength is required, strips of tin may be inserted here and there. When the casing is finished the patient is gently lowered to a horizontal position by bringing up behind him a vertical table swinging on a central transverse axis and provided with cushions, so that there may be no strain until the plaster is thoroughly set. Afterward it may be trimmed down under the arms and over the iliac crests if it descends too low. The movable pads are pulled out as soon as the casing is firm.

In disease of the cervical or cervico-dorsal vertebræ absolute rest is essential, until it is certain that the acute symptoms have subsided and the period of consolidation is well established. The patient lies perfectly flat with the head and shoulders fixed by means of sand-bags; and, as already mentioned, care must be taken to preserve the contour of the spine. Afterward some kind of appliance must be fitted to keep the head and neck at perfect rest.

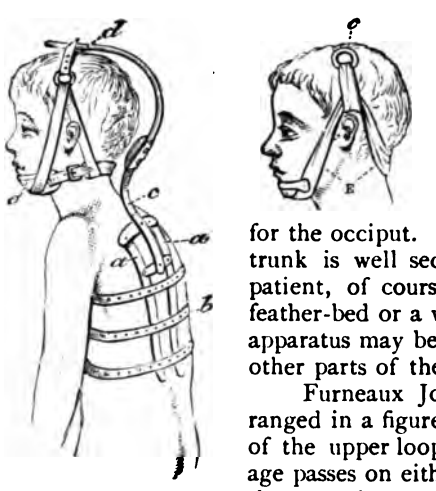

Fig. 309.—Sayre's Jury-mast.

The most useful is the modification of a double Thomas's splint devised by Krohne (Fig. 308). In this there is an upright on either side, coming from the thoracic crescent and supporting a pad for the occiput. When the head is fastened to this and the trunk is well secured, the immobility is complete. The patient, of course, must have either an exceedingly soft feather-bed or a water one for lying down. This form of apparatus may be used with great advantage in disease of other parts of the spine as well.

Furneaux Jordan recommends plaster bandages arranged in a figure-of-eight for cervical caries. The centre of the upper loop is on the forehead; from this the bandage passes on either side above the ears, downward on to the opposite scapula, and beneath the axilla, round the thorax. The jury-mast arrangement of Sayre (Fig. 309), however, is better than this, especially when the disease is below the axis, as it

mits a slight degree of rotation, and exerts a little steady extension. It con- of a metal rod, fastened below in the meshes of a plaster jacket, exactly op- te the spine, and curved so as to follow the outline of the neck, pass round occiput, and end on the top of the head. To this is attached a collar which pports the chin and the occiput, the degree of tension exerted by the metal being trolled by straps and buckles; a similar apparatus may be secured to a poro- tic jacket.

*Suppuration in Connection with Spinal Caries.*

As a rule, abscesses should be opened early and freely; leaving them, in the jority of cases, only enables them to become larger and more complex in shape, d an imperfect incision is a premium on putrefaction. Aspiration is of little vice, although occasionally in young children, when the condition is in other spects improving and the abscess is not increasing, it may be tried once, or even ice, in the hope that by reducing the tension, absorption may be set up. No ttempt should be made to empty the abscess, and very slight suction should be mployed, for fear of causing hemorrhage from the granulations. As a rule, if it used more than once or twice the opening fails to close, a little serum drains way, the skin becomes ulcerated, and the contents discharge themselves slowly and ntermittently.

[In these abscesses, lavage of the sac with iodine water, followed by injection iodoform emulsion, is of great benefit. The trocar and cannula used for acuation should be large enough to prevent clogging during the outflow.]

Where it is practicable, a spinal abscess of any size should be opened in two aces, one of which should be at the lowest point. If the interior is very irregular shape, divided into numerous pouches by stout bands of fascia passing across it uch, for example, as Poupart's ligament), it is of great advantage, wherever it is ssible, to make an opening into each. The object is not only to empty it of its ntents, but to keep it empty, and this is impossible with a complicated cavity, tering in shape with every movement of the body, if only one opening is made. such an abscess is thoroughly drained, so that there is no accumulation of putres- ble fluid possible, the caseous material that clings to the wall is thrown off by the anulations, the amount of discharge is reduced to a few drachms of serum, and l the outlying parts close up, leaving only one sinus leading down to the diseased ne. The drainage-tubes must be of the largest size, with walls sufficiently rigid t to collapse under pressure; and they must reach at first at least to the bottom each pouch.

If this is not feasible, either antiseptic dressing must be applied after Lister's an, in the hope that putrefaction may be prevented for an indefinite length of me, and that the abscess will empty itself of its contents by slow degrees and con- act into a sinus, or the interior must be washed out either continuously or at equent intervals, with some antiseptic, which, if it is retained by any accident, an outlying pouch, will not cause poisonous symptoms. Treves has employed ntinuous irrigation with water in one or two cases of psoas abscess with good sults.

A retro-pharyngeal abscess may break of itself before attention is drawn to it. it is diagnosed, it may be opened either through the mouth (with a guarded bis- ury, and taking care that pus does not enter the larynx), or externally by incision rough the skin of the neck. The choice of locality is determined by the direc- n the abscess takes. Sometimes a sequestrum is found.

Abscesses in the dorsal and lumbar region should be opened freely and plored with the finger to ascertain if there are any outlying pockets to be ained or fragments of carious bone to be removed. Sometimes the focus of sease can be reached directly, the softened bone scraped away, and iodoform plied.

Psoas abscesses should always be opened in the lumbar region. Poupart's gament divides the cavity into two, the upper half being usually much the larger;

possible to drain this properly from a single opening in Scarpa's triangle. The incision is longitudinal, by the side of the erector spinæ; all the structures down until the quadratus lumborum is reached; the fibres of this are incised at the tip of the third lumbar transverse process, and with them the anterior layer of the transversalis fascia; and then the finger is passed along the anterior surface of the muscle until the psoas is reached. The line of safety is the inner one, as the lumbar artery lies above and below. In some cases an incision of the kind may be utilized to get directly at the seat of the disease.

In most instances a second (and sometimes even a third) opening is required. This must be made in the situation in which the abscess points, either above Poupart's ligament (with an incision similar to that for tying the external iliac artery) or below it in Scarpa's triangle, or on the outer side or behind. I have, on several occasions, passed a large drainage-tube (half-inch internal diameter) through the whole length of the psoas, from the lumbar region to the thigh, with very great success, the temperature remaining practically unchanged; and after a time have divided this in the middle, so that the central portion of the abscess should collapse first. Usually it results in the inferior opening closing completely, and the upper one contracting into a small sinus, which, owing to its being practically straight, scarcely retains any discharge.

**Paraplegia.**—As the inflammation subsides and the caseous deposit shrinks, the paraplegia not unfrequently undergoes material improvement without direct treatment of any kind; and occasionally rapid recovery of power follows the application of a Sayre's jacket. This is due, in some instances, to the weight of the upper part of the body being removed and the pressure on the soft tissues relieved; but more frequently it only means that the trunk is better supported and the centre of gravity brought over the feet again. Counter-irritation is sometimes of service. The actual cautery, for example, may be applied either in lines radiating from the central projection, or a row of points may be placed in a circle around. The iron should be of a dull red heat, and the whole thickness of the skin should not be destroyed. An anæsthetic is advisable, and if the burns are covered over at once, so that the access of air is prevented, the subsequent pain is very slight.

McEwen, of Glasgow, has, on several occasions, resected the spines and laminæ of the vertebræ, exposed the sheath of the cord, and excised the dense, thickened, peri-meningeal connective tissue pressing upon it, with very great success; and this example has been followed by others. There is no doubt that where there is no pyrexia, where the symptoms point to pressure upon the cord without myelitis, and where, although the inflammatory process has ceased, the paraplegia does not improve, and is not influenced by treatment, an operation of this kind is not only justifiable, but strongly to be recommended. The incision should lie in the median line, and the periosteum with the muscles on either side should be stripped back, so that when the flaps are replaced a tolerably firm casing may be formed over the canal.

## Curvature of the Spine.

The spine may become bent, either from primary disease of the bones and joints (caries, osteo-arthritis, new growths, etc.) or from weakness of the muscles whose function it is to maintain the erect position, the vertebræ only becoming affected secondarily after the deformity has already lasted some time, owing to the unequal distribution of the weight they bear. The direction may be either antero-posterior or lateral, although the latter rarely occurs by itself. The former is known as excurvation or *kyphosis* when the projection is convex backward, incurvation or *lordosis* when it is convex forward; the latter as *scoliosis*.

### 1. *Antero-Posterior Curvature.*

Of these there are two well-marked varieties, distinguished from each other by [illegible] local dis[illegible]

bone; the other is uniform and gradual, caused, as a rule, by a general affection of the whole or part of the spine.

(*a*) *Angular.*—In by far the majority of cases this is the result of caries; but may arise from myeloid sarcoma affecting the body of one of the vertebræ, from aneurysm, carcinoma (secondary), and in infants from rickets. The projection, as the name implies, is sharp and angular, and it is exaggerated by the presence of compensatory curves in the opposite direction above and below. These are the natural result of the attempt to retain the erect position; if the spine is bent forward at any one spot, owing to a defect in the bone, the head and the upper part of the trunk must be thrown back in order that the centre of gravity may lie over the base line of the feet; in other words, one or more compensatory curves must be developed in the opposite direction. When this cannot take place, or is imperfect, as when the disease involves the last lumbar vertebra, the patient is compelled to stoop forward.

The diagnosis rarely presents any difficulty. In progressive *caries* the rigidity of the muscles, the tenderness over the spinous processes, and the care with which the patient avoids moving, especially in any way that might jar the back, are nearly always conclusive. These signs are lost to a certain extent, it is true, after the inflammatory stage is past and repair is complete; but the diagnosis is assured then by the fact that, with the exception of rickets, the other diseases that lead to the formation of angular curvature have little or no tendency to get well.

*Myeloid sarcoma*, except for the rapidity with which the curvature is formed, cannot be diagnosed from caries. The age is the same, and the symptoms are the same, especially as it is always attended by a certain amount of inflammation. Fortunately it is much more rare.

*Rickets* in infancy may be a source of considerable difficulty for a time, as the presence of this disease does not exclude caries as well. The spine of a rickety child retains for a long time the normal infantile curve, and if it is allowed to sit the weight of the upper part of the body, acting on the softened bone, may cause a very sharp bend to take place at the junction of the dorsal and lumbar region, where caries is most common. In most cases the diagnosis may be made by laying the child upon its stomach across the nurse's knee; a rickety curve can usually be straightened out by a little manipulation as soon as the weight is taken off, while in caries this is, of course, impossible, as the muscles retain their rigidity; but very often in the really severe cases of rickets this fails completely, as the bones are as tender and the muscles as rigid as in actual inflammation. Fortunately, in such cases, rest, cod-liver oil, and good food effect a complete transformation within a week.

(*b*) *Gradual.*—This may be caused either as a compensation for other defects, or by some affection of the back itself.

Compensatory curves have been already mentioned in connection with caries, but they are the natural result of many other deformities. Congenital dislocation of the hip, for example, and ankylosis of the hip joint in a flexed position, are of necessity attended by lordosis; and where this is at all extensive there must be a compensating degree of kyphosis above. The same thing occurs in abdominal tumors and even to a slight degree in pregnancy.

Weakness of the muscles of the back, such as commonly occurs in rickety children, or in those who have outgrown their strength, is a very frequent cause of kyphosis. Sometimes the body retains its symmetry and the spine remains in the middle line; more frequently it yields to one side or the other, and lateral curvature results as well. Infantile paralysis and progressive muscular atrophy occasionally lead to the same result. At first the bodies of the vertebræ are unaffected, but after a time they become wasted and thinned in front; the thorax is crushed together and the deformity is permanent. If rickets is present the change is much more marked, the softness of the bones.

The normal curves of the spines are often lost and replaced by a single curve, usually marked at the junction of the neck and thorax; and

a similar deformity is produced when the spinal column is affected by osteo-arthri or osteitis deformans.

### 2. *Lateral Curvature—Scoliosis.*

Lateral curvature may result either from want of symmetry in other parts of the body, the spine bending to one side to compensate for some other defect, and enable the head and centre of gravity of the trunk to be kept vertically over the base line of the feet, or simply from weakness, the muscles which ought to keep it straight not being equal to the work; in this case it is nearly always associated with antero-posterior curvature as well.

(*a*) *Asymmetry.*—Owing to its position in the central axis of the body, the spine is necessarily influenced by the least alteration in symmetry. Whether it is

FIG. 310.—The Ordinary Form of Lateral Curvature, Lumbar to the Left, Dorsal to the Right, with growing out of the right shoulder and a depression beneath the ribs.

the legs, or the arms, the thorax, or even the head, if one side predominates unduly over the other the effect is visible on the spine.

Inequality in the length of the lower limbs, for example, whether it arise from congenital defect (and the legs are unequal in length in many people, with its being suspected), fracture, disease of the hip, or any other reason, must ca curvature of the spine. The base line of the pelvis is oblique; the last lum vertebra must be perpendicular to it; and, consequently, if the person is to st erect, the spine above must be bent back to the opposite side.

Inequality in the strength or the development of the upper limbs produc similar though less marked result. The most striking examples are seen in c genital absence of one of the arms; but in people who are very distinctly ri

handed, the dorsal spine is always slightly convex to the right, and sometimes very decidedly so.

Asymmetry of the thorax is equally potent. In empyema, when the walls of one side have collapsed to the utmost, this is visible at once, the spine being concave to the diseased side; but even after an attack of pleurisy the same effect may be noted for some considerable time after recovery.

Even wry-neck produces the same result, although, of course, to a very much less extent. In neglected cases, in which the head is bent down for years, the side of the face, the chest, and in women even the mammary gland, fail to grow in proportion, and the spine becomes asymmetrical.

Finally, though much more rarely, lateral curvature may arise from some defect in the spine itself, caries, for example, affecting the body of a vertebra on one side; or one-half only of a vertebra being developed without the other. Paralysis of the intercostal or other muscles acting from the spine upon the trunk might cause the same result.

Occasionally, the deformity produced in this way is very considerable; but, as it is always secondary, developed to compensate for another, it naturally does not admit of rectification.

(*b*) *Muscular Weakness.*—This is the most common cause of the "growing out of the shoulder" (generally the right one), which is the symptom first noticed and first complained of in the majority of cases of lateral curvature. The muscles, which ought to keep the spine erect, are unable to do so, and it bends over to one side, and, generally speaking, forward as well. It may be a young, rapidly growing girl, whose strength, especially at puberty, is unable to support the weight of the upper part of the trunk; or a person of better physique who has to carry constantly upon one arm or shoulder a load that is too heavy; it may be the outcome of some exhausting illness, or even of a strain injuring some of the muscles: the cause is the same in all, the weight is out of proportion to the strength.

The direction of the curve is determined by some slight degree of asymmetry, natural or acquired. In right-handed people in whom there is a dorsal convexity this is the guiding cause. The posture known as standing at ease is another; the weight of the body is allowed to rest on one leg, the other side of the pelvis droops, the base line becomes oblique, and with it the axis of the lumbar spine. To compensate for this the thorax is thrown over to the opposite side. In other cases the primary curve can be traced to a cramped position in writing, or to other causes.

This variety of lateral curvature is entirely different from the former; it is a primary affection, not developed to compensate for anything else; and, unless steps are taken to prevent it, it has a very great tendency to become worse. In many cases, it is true, it is arrested spontaneously; the period of growth and of physical weakness comes to an end, and the muscles develop sufficiently to prevent the curve becoming more distinct; but it rarely happens unless the treatment is thoroughly carried out, that this state is reached without leaving some degree of deformity. As patients become stronger, the curve ceases to increase, but they do not grow out of it, in spite of the popular opinion to that effect.

Curves in the spine are naturally unable, in the majority of cases, to remain single. Where the lumbar region is convex to the left, the thoracic must be equally convex to the right, and sometimes the cervical must be bent back again in order to keep the head and the centre of gravity over the base line of the feet. One of these curves is usually considered the primary, the others compensatory; but they must, with few exceptions, develop together.

**Rotation.**—Except in some cases of thoracic asymmetry, lateral curvature of the spine never occurs alone. It is always and necessarily associated with another deformity (rotation of the vertebræ on a vertical axis), which is even more hard to correct, and which causes much greater distortion of the trunk. The direction of this rotation is absolutely constant; the bodies of the vertebræ are

always twisted further away from the middle line, and the spines brought near to it. The effect, if the deformity is estimated by the spinous processes alone, is very deceptive; sometimes they are rotated so far back that they are almost brought to the median groove again, vertically under each other, as if the spine was practically straight, while in reality the bodies are carried further and further away until they may face to left and right, instead of forwards. The rotation apparently corrects the deformity; in reality it makes it infinitely worse.

The cause of this rotation has been the subject of much discussion. Where there is general muscular debility, it can hardly be due to muscular spasm. As a matter of fact it is purely mechanical, the result of the fashion in which the vertebræ are articulated together. As soon as the least lateral curve makes its appearance, the weight of the upper half of the trunk presses obliquely on the lower part of the spine; and, like all oblique forces, it may be resolved into two, one acting vertically, the other horizontally. Of these the latter only is concerned with the rotation. It acts almost wholly upon the bodies which are not supported by anything

FIG. 311.—Lateral Curvature with Slight Rotation, bringing the spines back to the middle line, and making the real deformity worse.

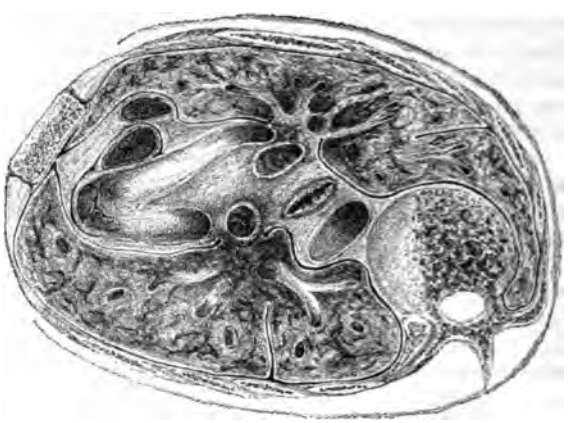

FIG. 312.—Extreme Distortion of Thorax consequent upon Lateral Curvature of the Spine. The section passed through the articulation of the second costal cartilage with the sternum on the left and the seventh dorsal vertebra on the right. The vertebra, being just at the junction of the two curvatures, shows very little rotation.

laterally; upon the spines which have little or nothing to do with bearing the weight of the trunk, and which are protected on either side by the articular processes, it has little or no effect; and, consequently, the former are deflected so much more forcibly than the latter that the vertebræ swing round upon an axis running down the central canal, the bodies going one way, more out of the perpendicular, the spines the other.

**Effect.**—In the slighter cases, in which the muscular system soon regains its strength, no gross changes are produced. In the more severe ones, and in those dependent upon asymmetry, the whole of the trunk is affected more or less. The vertebræ on the concave side are wasted from the pressure, so that the bodies become wedge-shaped; the ligaments and muscles are shortened; and the fibro-cartilage is shallower on one side than the other. Sometimes in very severe cases buttresses of bone are thrown out from one vertebra to another, as in rickets, for the purpose of sup- On the convex side the ribs diverge, so that the shoulder is raised, on the ey converge; so that it is equally depressed;

structures that follow the course of the spine, such, for example, as the aorta, ome strangely twisted into an S shape.

The rotation complicates this still more; the vertebræ are twisted as well. ad cases the bodies may look half to the left and half to the right, instead of straight forward; and in the lumbar region the transverse processes on the con- side may project so directly backward as to be mistaken for the spines. This ot without its effect upon the vertebræ; their symmetry is entirely lost; the e and the transverse process on the convex side are twisted toward each other; se on the concave side apart. The thorax shows the deformity even more con- cuously. The ribs on the convex side diverge and project backward, carrying scapula with them; then they bend back upon themselves so sharply that the e antero-posterior diameter opposite the nipple is only a few inches. On the ncave side they run forward in the opposite direction, with scarcely any angle all, so that the sternum is carried far away from the middle line toward the ncavity, and the breast on that side is thrust as prominently forward as the other e is depressed. In extreme cases the ribs on the concave side are crushed to- ther, while those on the other grow outward and backward further and further til their angles produce a lateral hump which at first sight is not unlike that due caries (Fig. 313).

The effect of this upon the thoracic and abdominal viscera is most serious. e chest is crushed down from above, twisted round, and fixed in such a way that n when synostosis does not occur between the ribs, pansion is out of the question, and respiration must be rely diaphragmatic. The lungs are displaced, altered shape, and unable to move in the pleural cavity; the rt is thrust to one side; the aorta is doubled almost n itself; and the liver and kidneys are forced alto- her out of position; in short, there is not one of the era that does not suffer more or less severely.

FIG. 313.—Extreme Scoliosis.

In children, especially when there is a tendency to ets, the vertebræ very soon become altered in shape; then the deformity is practically permanent, although e improvement may be effected if the treatment is menced before the period of sclerosis and condensa- sets in. When the disease does not commence until erty, the bones do not suffer so soon, and if only onable care is taken and proper treatment carried out l full growth is reached, deformity can be altogether ented. It is very rare for lateral curvature to com- ce after one and twenty, although if there is any dy existing deformity, it is not uncommon for it to become worse.

Knock-knee and flat-foot occur under the same conditions as lateral curvature e spine, and are very commonly associated with it.

**Symptoms and Diagnosis.**—The lateral curvature in asymmetry gives to no inconvenience (unless, as sometimes happens in fractures, the inequality oduced suddenly and late in life); and if the muscles are well developed it has endency to become worse. It is the result of compensation and does not it of correction.

When due to physical weakness its first commencement very rarely receives attention; the nature of the complaint is not suspected until the alteration in igure (generally the growing out of the right shoulder) is distinct. The patient have been in the habit of standing on one leg for some time past; or of ping with the head poking forward, the shoulders rounded, and the abdomen ecting; but as a rule this is the first thing to cause a suspicion that there is hing more serious than simple laziness.

It is practically confined to childhood and youth, and is much more common irls than boys. To some extent this is due to the very great strain upon the

strength at puberty, especially as this is often accompanied by a period of rapid growth; but there is no question that it is largely the result of different habits and modes of life, and especially of insufficient and improper exercise, not enough attention being paid to the development of the muscular system.

Pain is unusual, although when the disease is advanced it may be very severe, possibly from pressure upon the intercostal nerves. Very often there is a vague sense of aching in the lumbar region, especially of an evening and after exertion; and with this there may be some cutaneous tenderness over the bony prominences, such as is not unfrequent in convalescents. In most cases, however, this is either neglected as natural in connection with the time of life, or is stigmatized as growing pain; and as practically there are no other symptoms, the patient is regarded as simply having outgrown her strength, until, suddenly, the want of symmetry is observed.

**Method of Examination.**—The clothing is arranged so that the body above the iliac crests and the gluteal cleft can be inspected from all sides. If, from the height of the crests, there is any reason to suspect inequality of the lower limbs, this must be investigated first, and compensation made by placing a book under the shorter leg.

At first the patient stands upright with the feet together, in a natural, unconstrained position. If the muscles are rigid and contracted, so that the attitude is stiff, they nearly always give way in a minute or two. In the meantime the tip of each spinous process is marked with an aniline pencil. In an ordinary case, with the dorsal convexity on the right, the scapula on that side is higher and more prominent, the chest fuller, and the iliac crest better marked, with a deep depression between it and the ribs (Fig. 310). On the left the outline of the body is nearly straight. Seen from the side, the head projects forward, the thorax is flat, half-concealed by the shoulders, and the lower part of the abdomen projects, owing to the antero-posterior bend which, when the muscles are weak, nearly always complicates the lateral one. In front, the left breast stands out more than the other, and the asymmetry of the thorax is even more distinct.

Next the patient is directed to stoop forward, the knees being kept straight, the head bent down, and the arms hanging loosely in front. This gives an idea of the amount of rotation. The ribs posteriorly are uncovered; and the projection backward of the lower part of the chest on one side, and of the erector spinæ in the lumbar region on the other, is brought prominently into view. It is often of service to keep a record of this position by moulding a malleable piece of lead (as suggested by Roth) transversely to the ribs, between the angles of the scapulæ, and taking a tracing from this on to paper. If the deformity is conspicuous a second may be taken opposite the third lumbar spine.

Afterward the patient is directed to straighten her back by her own unaided efforts; and if, as is probable, this merely results in increasing the deformity, an attempt must be made by manipulating the trunk and the limbs to see how far it is possible for the muscles to restore the symmetry. In cases in which there is no osseous deformity this can usually be done by placing the patient in what Roth has called the key-note position, with the right arm directed upward, and the left one at right angles to the trunk.

The prognosis depends chiefly upon the state of the vertebræ. If they are not yet affected, the patient can generally be cured, if she will take sufficient trouble, although relapses are almost sure to occur from time to time until the development of the trunk is complete. If, on the other hand, osseous deformity is already present, neither rotation nor curvature can be corrected, except in very early cases, and where there is evidence of recent rickets, all that can be done is to prevent them becoming worse.

**Treatment.**—The essential point is to strengthen the muscles by regular and systematic exercises, without fatiguing them.

Good food, fresh air, iron, cod-liver oil, and tonics are essential, as patients who suffer from lateral curvature are nearly always anæmic and often c

e clothing should be arranged so as to avoid compression of the lower part of thorax; if stays are worn they should be short, and there should be a vertical p of elastic on each side, to admit of easy expansion, and great care must be en to avoid injurious habits, which, if they have not caused the deformity, ve at least made it worse, such as long standing, especially standing at ease; ting obliquely in a cramped position when writing without a proper back-rest, with the legs crossed, and stooping. The back should be well sponged and bbed every morning, and massage, stroking and kneading the muscles on either le of the spine, and galvanism, should be applied to relieve the aching and sense fatigue which are nearly always present at first after any little exertion.

Where the muscular strength is good, and the curvature only slight, general xercises may be prescribed, especially swimming, balancing a light weight upon he head, swinging by the hands, and the use of a light pair of dumb-bells. Many f the exercises on the horizontal bar may be performed as the general nutrition mproves; but, whatever is done, the patient should always stop short at the least ensation of fatigue, and should rest upon a properly-shaped chair, with the seat horizontal, a foot-rest, a cushion arranged to fit the loins, and an excavation above for the shoulders. A similar chair, with the back adjusted so that the angle can

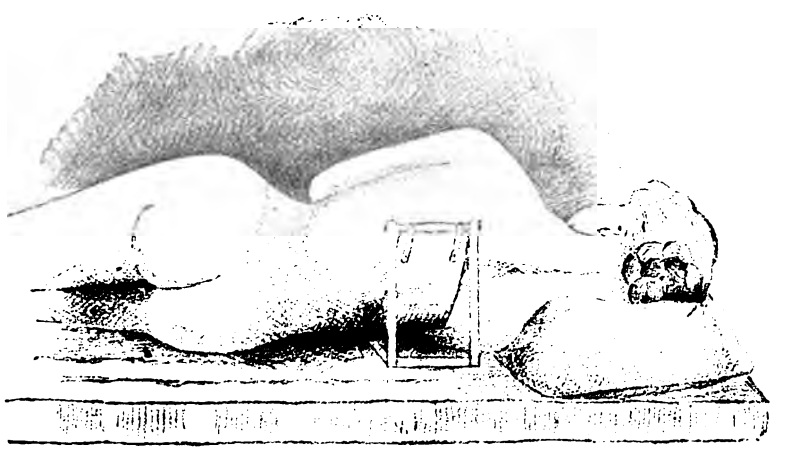

FIG. 314.—Barwell's Sling for Correcting the Rotation in the Recumbent Position.

ltered, should be used for all purposes—meals, playing the piano, writing, etc. ight Barwell's sling (Fig. 314) is sometimes of service.

In more severe cases, in which the strength is unequal to this, much milder rcises, limited to special groups of muscles, must be prescribed; the intrinsic scles of the thorax (deep inspiration and expiration), those of the head and k, those of the upper extremity that act upon the trunk, then those of the er (circumduction of the shoulder and hip), the erector spinæ, the abdominal up, etc., being worked quietly and slowly, one after the other, a certain number times (depending upon the strength of the patient), first, so far as possible, in recumbent position, then erect. The same precaution as to fatigue must be opted here; and after each practice the muscles of the back should be well rubbed sponged.

As Roth has pointed out, it is essential, first of all, to correct the antero-sterior curvature. Afterward, when the muscles have regained their power over s, exercises may be practiced in the key-note position, or in that which tends st to bring the spine to its natural shape. Later ones may be more severe, as, example, when the patient, lying prone upon a table with the pelvis and legs ported, and the latter fixed (by some one sitting on them), raises the trunk w to the horizontal position and slowly lowers it again.

During this treatment Roth recommends that the patient should stand frequently in front of a looking-glass with the eyes closed, and straighten herself until she believes that she is standing erect; generally she finds, on opening her eyes, that the head is on one side, and one shoulder unduly raised. By degrees the muscular sense, which requires re-educating, becomes so much improved that she is enabled to place herself in a better position voluntarily, and at once.

Mechanical supports should never be used for lateral curvature of the spine when it is possible to avoid them, and then only in the daytime, not when the patient is lying down. Where there is paralysis of the muscles of the back, or where, as I have seen on one or two occasions, lateral curvature has developed rapidly after a severe strain (some of the muscles probably being ruptured or so stretched that, for the time at least, they were paralyzed), they are undoubtedly beneficial as adjuncts, only they must be gradually left off as the muscles regain their power. To keep them on only causes atrophy. In advanced cases, in which the deformity is so great as to resemble angular curvature in appearance, and the muscles are hopelessly wasted, their use cannot be avoided; the deformity is permanent, and it is only possible to prevent its becoming worse by supporting the trunk. Many of these cases suffer very severe pain, probably from pressure upon the intercostal nerves, and only experience relief when wearing some kind of mechanical support.

## Inflammation of the Spinal Cord and Meninges.

### *Acute Traumatic Meningitis.*

This is not uncommon after wounds that involve the membranes, or after gunshot injuries of the vertebræ; the former are nearly always punctured, the latter are invariably bruised, so that there is everything to favor septic inflammation; and under these conditions it may commence in the membranes themselves. Much more rarely it is met with after injuries that are not compound, such as sprains, wrenches, and simple fractures, and then it is generally due to the extension from surrounding structures. Periostitis or arthritis breaks out and runs on to suppuration; or an abscess forms in the crushed and bruised tissue around the theca and between the bones; or the inflammation starts outside the spinal column altogether, and spreads into it along the nerves or lymphatics, or more directly through a rupture in some of the posterior ligaments.

The pathological appearances naturally differ to a certain extent; sometimes the effusion seems to be limited, but more frequently the pus spreads down the whole length of the theca and involves the subdural as well as the subarachnoid space. In extreme cases the cord is injected and softened so as to be almost diffluent; and the pia mater is thickened and infiltrated with lymph which spreads along the veins like white streaks on either side.

It may begin within a day or two after the accident, or when it is due to gradual extension it may not make its appearance for a long time. As a rule there is a rigor or shivering; the temperature rises at once, and may become exceedingly high in the first few hours; the pulse becomes full and rapid; the respiration is shallow and hurried; vomiting is not infrequent; and delirium and other signs of the most intense fever follow very soon. Reflex action is at first exaggerated; very soon it begins to fail; voluntary power is impaired almost from the first. There is the most intense pain down the back, often spreading round the trunk as the roots of the spinal nerves become involved; hyperæsthesia is almost always present, and sometimes it is general, so that the weight of the bedclothes on any part of the body causes agony; the muscles of the back are kept perfectly rigid; often there is opisthotonos, the back of the head boring into the pillows; and sometimes there are violent spasmodic contractions of the muscles of the limbs and even general epileptiform convulsions. As a rule respiration soon

# CHAPTER IX.

## *SURGICAL INJURIES AND DISEASES OF THE EYE.*

By J. Hutchinson, Jun., F.R.C.S.

### 1. The Methods of Examining the Eye. Errors of Refraction.

For ophthalmic work, the student should be provided with the following: a refraction ophthalmoscope (of which there are many varieties, the one designed by Mr. Stanford Morton being perhaps the best), and a large convex glass lens having a diameter of two inches and a focal length of about three inches. In addition to these, for estimating refraction, a "keratoscopy mirror" is useful, and a pupillometer should be added to the ophthalmoscope case.

By "oblique illumination" of the eye is meant the projection of light from a lamp at the side of and somewhat in front of the patient's head through the convex lens into the eye, the lens being held at about its focal distance from the latter. Oblique illumination is especially valuable for detecting opacities or "nebulæ" in the cornea, foreign bodies on the latter, or commencing cataract.

By "indirect ophthalmoscopic examination" is understood the following: The patient is seated in a dark room with a light behind and to one side of his head; the observer uses the plane mirror of the ophthalmoscope at a distance of about eighteen inches, and reflects the light into the pupil of the patient's eye; then interposing the convex lens, held in the left hand at rather less than its focal distance from the latter, the patient is directed to look at the observer's right ear if the right eye is being examined, at the left ear if the left eye is under observation. By this means an inverted image is obtained of the optic disc, and the whole fundus can be explored by making the patient look upward, downward, and to either side. It must be remembered that the image obtained is an inverted one, and hence, for instance, a hemorrhage seen apparently above the disc is really situated below it.

In the "direct method" of examination, on the contrary, the image obtained is not inverted. The oblique mirror of the ophthalmoscope is used, the light being as near as convenient to the patient's ear; the surgeon, using his right eye when examining the patient's right one and *vice versâ*, approaching his eye and instrument until the latter is just in front of the cornea, whilst reflecting the light steadily into the pupil. If the patient looks straight forward, the optic disc will be seen; if straight at the observer, the region of the macula or yellow spot can be explored, etc. Since reflecting the rays on to the latter region produces reflex contraction of the pupil, it is a great convenience if the contractor pupillæ be paralyzed by homatropine. In estimating refraction, too, the previous use of this drug is often necessary, especially in young subjects and in those with hypermetropia or "long sight." An aqueous solution of homatropine hydrobromate (four grains to the ounce) is employed, two or three drops being applied within the conjunctival sac every ten minutes. After this has been repeated three or four times, practically complete paralysis of the ciliary muscle and contractor pupillæ is obtained, both muscles recovering within twenty-four hours. For ophthalmoscopic use, homatropine has largely displaced atropine, since the paralytic effects of the latter often persist for nearly a week. Further, if atropine be used in patients of advanced age, there is a certain risk of causing glaucoma.

The student should practice the use of both direct and indirect ophthalmoscopic examination, since both are indispensable. We may now briefly notice the methods of detecting and estimating errors of refraction by the ophthal

In *hypermetropia*, otherwise known as long sight, the eye is shorter than usual, and if the ciliary muscle be at rest, parallel rays are brought to a focus behind the retina. Rays proceeding from an object at a distance of twenty feet or six metres may be regarded as parallel ones. Hence a hypermetropic eye, if the ciliary muscle be for the time not in action, has a certain amount of defect in distant vision, a defect which the patient can overcome by contracting his ciliary muscle, rendering the lens more convex, and thus bringing the rays to a focus on the retina. Rays proceeding from a near object, *e. g.*, the type of a book, can also be brought to a focus on the retina with extra use of the ciliary muscle, and it is in near vision that the hypermetrope nearly always notices his defect, the strain upon the accommodation causing aching in the eyes or head.

Hypermetropia may be detected by the surgeon by the following means:—

1. In using the indirect method, if the image of the disc be obtained and then the surgeon gradually withdraw his mirror and lens whilst keeping the disc in view, the size of the image will be noticed to decrease.

2. If the direct method be employed, as the observer approaches the patient whilst reflecting the light into his eye, an image of the retinal vessels will be obtained at a distance of some inches from the eye. This image will appear to move (from side to side or vertically) in the same direction as the observer's eye. The distance at which the vessels can be distinguished varies with the degree of hypermetropia.

3. The observer uses the keratoscopy mirror (or the plane one in his ophthalmoscope) at a distance of at least one metre, and reflects the light from the lamp placed above and behind the patient's head into his cornea, making a shadow pass across the latter by inclining the mirror. If the shadow passes across the cornea in the direction opposite to the one followed by the mirror, the eye examined is either hypermetropic or emmetropic (of normal refraction). The test being repeated with a lens * of + 1 D (40″) focal length immediately in front of the patient's eye, if the latter be emmetropic there will be no moving shadow. If hypermetropic, lenses of increasing strength are used until the shadow movement ceases, when the deduction of about 1 D from the lens required to effect this will give the amount of hypermetropia.

4. By using the direct method the details of the disc can be clearly seen in a hypermetropic eye when + glasses are used in the ophthalmoscope. The highest lens with which the smaller vessels can be distinctly seen represents the total amount of hypermetropia. The observer's eye in this test must be brought close to the patient's.

It must be remembered that these methods of estimating the amount of hypermetropia are only available if the patient be relaxing his accommodation, and most easily if the ciliary muscle be temporarily paralyzed by homatropine or atropine.

In *myopia* or short sight precisely the same tests are employed: in (1) the size of the image increases as the lens and ophthalmoscope are withdrawn; in (2) the image moves in the opposite direction to the observer's head; in (3) the shadow moves across in the cornea in the same direction as the mirror is tilted; and in (4) the details of the disc cannot be clearly defined unless a — lens equal to the amount of the patient's myopia is used in the ophthalmoscope.

A myopic eye is one in which the length of the globe is greater than normal, and therefore parallel rays passing through the cornea are brought to a focus in front of the retina. Hypermetropia is a congenital condition, does not tend to

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* The unit of the Dioptric System, which is now universally employed, is a lens of about 40 English inches focal length; + 2 D signifies a convex lens of $\frac{1}{2}^{0} = 20''$ focal length, — 5 D a concave lens of $\frac{5}{8}^{0} = 8''$ focal distance, etc. To convert the French into the English system, divide the number of dioptres into 40. The standard of normal acuteness of vision is represented by $\frac{6}{6}$, *i. e.*, letters which subtend an angle of 5° at the distance of 6 metres (about 20 feet) are used and can be read at this distance. $V = \frac{6}{12}$ implies that the patient can only read at 6 metres type which subtends this angle and should be read at 12 metres distance, etc.

increase as age advances, but, on the other hand, occasionally becomes less. Myopia usually comes on when the eyes begin to be used much for near vision—*i. e.*, at school or during early adult life—and tends to increase with more or less rapidity. Overwork of the eyes (especially in a bad light), the habit of stooping and bringing the book, etc., very near to the eyes, and reading small or bad print, favor the progress of myopia. Twelve inches is about the best distance for near vision, and if the amount of myopia be so great as to compel the patient to hold his books, etc., nearer than this, concave glasses should be given of a sufficient strength to enable him to read comfortably at about this distance. For good distant vision a myopic patient may be ordered the full correcting glasses, and if these do not exceed — 4 D or — 5 D, they may be used for both near and distant vision.

A hypermetropic patient has no difficulty in distant vision, as a rule, but the extra strain thrown upon his ciliary muscle in near work tends to produce pain in the eyes and headache (especially frontal), and these symptoms may be entirely relieved by ordering the full correction to be worn for near vision.

*Complications of Hypermetropia and Myopia.*—The chief complication of hypermetropia is convergent strabismus, the form of squint most often met with in practice. In this, whilst one eye is directed upon a near object, the axis of the other passes to its inner side (*i. e.*, between the object and the non-squinting eye). Generally the squint affects the same eye always; it is then said to be constant, and the vision of the affected eye is often defective (*e. g.*, $\frac{6}{60}$). The image is mentally ignored, and hence the patient does not complain of double vision. Convergent strabismus comes on in childhood, and if the case is seen early and the squint be not of very high degree, it can be cured by the continuous use of fully correcting glasses (*i. e.*, those equal to the total amount of hypermetropia found). It must not, however, be expected that vision will much improve in the defective eye, though it is well to advise the patient to practice this eye by covering the other from time to time. If the squint be alternating (that is, if first one eye squint and then the other) vision is usually good in both.

If the strabismus has existed for some years, or if it be of high degree (20°–30°), probably a tenotomy of one internal rectus muscle will be required. In most cases it is advisable to give the correcting glasses a trial for some months, and then to perform the tenotomy if the squint is still present, ordering the patient to continue their use after the operation.

There are several complications of myopia, especially if it tends steadily to increase. Perhaps the most frequent is the occurrence of floating specks (muscæ volitantes) seen before the eye, and due in some cases to actual opacities in the vitreous, though often none can be detected.

Hemorrhages into the vitreous or retina, detachment of the latter from the choroid, and atrophic patches in the region of the yellow spot (choroiditis posterior) are serious and not uncommon results of progressive myopia.

Owing to the strain put upon the internal recti, divergent strabismus may come on, and give rise to double vision. Besides ordering suitable glasses for a myopic patient, the surgeon should caution him against too prolonged work with the eyes, and should insist upon the light used in the evening being steady, of good quality, and so placed that the glare may not come upon the eyes themselves. Tonics also may be of use, and means should be taken to prevent stooping at the work, and books with very small or bad type should be avoided. If divergent strabismus is present, it may be treated by division of one or both external recti, or by advancement of one internal rectus.

A very constant ophthalmoscopic feature of high myopia is the formation of a whitish crescent at the outer side of the disc, due to the exposure of the sclerotic by the shifting of the choroidal edge (this is known as a *posterior staphyloma*).

In both simple hypermetropia and myopia parallel rays are brought to a focus either behind or in front of the retina when the accommodation is at rest. But sometimes one meridian of the cornea or lens is more curved than

ı such a case the rays passing through the two meridia are brought to differ-
ɔci. Such a condition is termed *astigmatism.* If the two meridia are at
angles to each other, as is usual, the astigmatism is said to be regular, and
ɜ corrected by suitable cylindrical lenses. If, on the other hand, one small
ıf the cornea is more refractive than the rest (as in conical cornea or after
tion) the astigmatism is said to be irregular, and cannot be benefited by
s.

\s a rule, in regular astigmatism the vertical meridian of the cornea is more
tive than the horizontal: if both are myopic, the case is said to be one of
ɔund myopic astigmatism, etc.; if one meridian is myopic and the other
metropic, the term mixed astigmatism is used. Often the meridia are not
al and horizontal, but placed obliquely, whilst still at right angles to each
. Then the exact obliquity has to be carefully ascertained, and for deter-
ıg this keratoscopy is invaluable, its result being always confirmed by trial
ɔylindrical glasses in distant vision.

Regular astigmatism is, as a rule, congenital. Low degrees are very common
ıay give little or no trouble; occasionally it is left after extraction of cata-
ır iridectomy, owing to traction on the cornea by the scar of the operation
d.

\part from the errors of refraction we have briefly noticed, we have to con-
weakness of sight due to muscular failure and to senile changes in the eye.
ɔower of accommodation for near objects depends on two factors—the strength
ɜ ciliary muscle and the elasticity of the lens; and it steadily decreases from
ıood to old age. It may be represented by the highest concave lens which
ɜe overcome by contraction of the ciliary muscle—thus, for instance, a
ıt with normal vision, at the age of 15, can overcome a lens of — 12 D
can read $\frac{6}{6}$ still by an effort when this lens is placed before his eye). The
r point" (the shortest distance from the eye at which it is possible to read
will be represented by 40 divided by 12 or $3\frac{1}{3}$ inches. At 45 years the
ımodation is only 4.5 D and the near point 9". It is about at this age that
ɔomes necessary to assist the accommodation with convex lenses for near
, and the following table indicates the requisite correction for *presbyopia* or
sight."

| | Glass required for Reading at about 12", etc. | Age. | Glass required for Reading at about 12", etc. |
|---|---|---|---|
| . . . . . | + 1 D | 65, . . . . . | + 4.5 D |
| . . . . . | + 2 D | 70, . . . . . | + 5.5 D |
| . . . . . | + 3 D | 75, . . . . . | + 6 D |
| . . . . . | + 4 D | | |

The onset of presbyopia is delayed by myopia, hastened by hypermetropia; a patient with myopia of — 4 D may not require glasses for reading until the f 60; a patient with + 2 D of hypermetropia will need about + 3 D for read- t 45 years, etc.

ɜn early life the ciliary muscle may be temporarily weakened from various ɜ—diphtheria, prolonged suckling in women, etc. Difficulty in near vision ching of the eyes may also depend upon strain of the internal recti muscles overwork, and in a few cases prisms are of service. As a rule these cases of ıenopia" are best treated by tonics, rest of the eyes, out-door exercise, and measures to improve the general health of the patient.

## SECTION I.—INJURIES.

### 1. Burns and Scalds.

In cases of simple burns of the face the eyelashes are often temporarily destroyed, and muco-purulent conjunctivitis is not infrequently observed. The extreme sensibility of the cornea and conjunctiva render the slightest burn or scald of these parts very painful, and continuous cold applications (iced water or boracic solution) and pure cocaine used with vaseline are very useful in relieving the pain. As soon after the accident as possible it should be ascertained whether the cornea has been damaged, for the prognosis as regards vision will depend chiefly upon this point. If a whitish opacity is seen a very guarded prognosis should be given, since it rarely clears off completely, and in some cases the whole cornea may slough. If the ocular or palpebral conjunctiva be much burned, adhesion of the two (symblepharon) is very likely to take place—and during the healing process this adhesion should be limited as far as possible by the frequent insertion of boracic acid ointment or vaseline. Scalds from quicklime, sulphuric acid, caustic potash, or soda, etc., are not infrequent, and in their treatment a weak neutralizing solution (acid or alkaline) should be freely syringed between the lids. Any particles of lime or mortar, etc., which may have got into the palpebral sacs should be removed by syringing, the use of forceps, etc., and in severe cases (especially in children) it is best to give an anæsthetic in order to effect this thoroughly.

Lead lotion should not be used in these cases, for fear of lead deposit on the cornea.

### 2. Foreign Bodies.

The removal of foreign bodies from the corneal surface is described under Diseases of the Cornea; sometimes a piece of iron is driven into the anterior chamber, the lens or the vitreous. In such cases its removal has been frequently accomplished by the use of the fine-pointed electro-magnet introduced through the original wound or a fresh one made with a narrow keratome. The "cannula-forceps" is also of use if the foreign body is not of iron and can be readily seen. Traumatic cataract is certain to result if the lens capsule is wounded by a foreign body; it should be treated by continuous cold applications and the frequent use of atropine for a few days. The lens swells up, becomes milky-white and generally protrudes into the anterior chamber. So long as the tension of the globe remains normal no other treatment is needed than that mentioned; but if it is distinctly raised and there is marked pain and congestion, it may become necessary to incise the periphery of the cornea with a narrow keratome and let out the soft opaque matter with a curette introduced into the little wound thus made. Atropine and ice should be again employed after the operation.

Although a foreign body may remain embedded for long in the vitreous, sclerotic, etc., without giving trouble, as a general rule an eye with such an injury retains but little sight, and is to a certain extent liable to set up sympathetic ophthalmia in the other one. Severe inflammation or suppuration of the injured eye may result from the introduction of septic matter with the foreign body, and in this case excision of the globe should be performed. The same rule holds good if there is reason for believing that the eye (although quiet) contains a foreign body and has permanently lost all visual power.

### 3. Wounds.

Abrasions of the corneal surface produce much pain and photophobia, and in elderly people may be the starting point of hypopyon, iritis, or serpiginous ulcer-

tion. Continuous warm boracic fomentations, the use of cocaine and (if there be any suspicion of iritis) of atropine, form the suitable treatment.

Perforating wounds of the cornea are very liable to be attended by prolapse of the iris, which follows the escape of the aqueous humor. Cocaine having been used (in certain cases general anæsthesia is better), an attempt should be made to reduce the prolapsing part with a small curette or caoutchouc spatula; but if this fails the protruding part of the iris should be gently drawn forward with fine forceps and snipped off with scissors. Either eserine or atropine should subsequently be used for some days, so as to draw the rest of the iris away from the wound; eserine if the latter is in the periphery of the cornea, atropine if it is central or if there is fear of iritis.

Any wound of the sclero-corneal junction or involving the structures immediately in front of or behind this spot, is dangerous, owing to the risk of *sympathetic ophthalmia*. This disease consists essentially in an iridocyclitis of the non-injured eye, coming on usually within a few weeks (but sometimes many months or even years) after the date of injury. Sometimes it takes the form of serous iritis with spotted opacities on the back of the cornea, sometimes optic neuritis develops. But the usual form consists in iritis leading to tough adhesions and secondary cataract, and tending slowly to completely destroy the sight. What is the explanation of this disease, whether some infective material is conveyed into the circulation from the injured and inflamed eye and lodges in the other one, or whether the inflammation travels along the optic or ciliary nerves, remains doubtful. The important fact to remember is that (with rare exceptions) sympathetic ophthalmia is due to a wound involving the ciliary region, especially if it inflames; and hence immunity from the disease is worth procuring at the expense of excision of the injured eye, if the latter retain little or no vision; for removal of the exciting eye *after* sympathetic ophthalmia has come on is useless.

FIG. 315.—Prolapse of Inflamed Iris through a Wound of the Cornea. *a*, cornea; *b*, prolapsing part of *c*, the iris; *d*, ciliary region.

The treatment in the latter case consists mainly in using atropine, counter-irritation to the temple and protecting the eyes from light. Mercury, quinine and belladonna given in full doses have each their advocates.

Occasionally a free iridectomy, performed after the acute stage has passed off, is useful.

*Sympathetic irritation* is a less severe complication of wounds of the eye, though sometimes it passes on to true ophthalmia. Its symptoms are attacks of congestion and watering of the non-injured eye, failure of accommodation, irritability on exposure to light, etc. In such a case it is best to excise the injured eye.

### 4. Contusion or Concussion Injuries.

In most cases of "black-eye" the globe itself escapes injury; the best way of obtaining absorption of the extravasation consists in using warm fomentations after the first twenty-four hours (during which cold should have been applied). The following may result from blows involving the eye itself:—

1. *Traumatic mydriasis—i. e.*, fixed dilatation of the pupil with more or less failure of accommodation. It is a singular fact that this mydriasis may persist for many years, or may disappear in a few days.

2. *Hemorrhage into the anterior chamber* is of slight importance, since the blood is rapidly absorbed under belladonna fomentations. Hemorrhage into the vitreous is much more serious, and generally affects the vision permanently. It must be suspected to have occurred after an injury, when (the lens and cornea

being clear) no reflex can be obtained from the back of the eye on ophthalmoscopic examination. Sometimes the floating clots can be detected by oblique illumination.

3. *Dislocation of the lens* may be either into the anterior chamber or (more commonly) into the vitreous; a very slight displacement is of serious import as regards vision. It may be suspected from tremor of the iris on sudden movement of the eye, and from bulging of the iris at one part and recession at another. If the pupil be dilated the edges of the lens can usually be detected as a dark colored line if it is dislocated. Cataract and glaucoma are both liable to ensue, and in some cases the displaced lens causes iritis, or shrinks up or calcifies. Any treatment but excision of the eye is as a rule useless.

4. *Rupture of the Globe.*—This usually occurs at or toward the ciliary region where the sclerotic is thinnest, and calls for excision in most cases. Both lens and iris have, however, been completely extruded through a rupture and the eye has retained some vision.

5. *Detachment of Part of the Iris from its Ciliary Origin.*—This is known as "coredialysis," and may not be limited to one point.

6. *Rupture of choroid or retina*, generally recognizable with the ophthalmoscope as linear bands of white with pigmented borders. Its effect upon vision will depend upon whether the rupture involves the yellow-spot region or not. Detachment of the retina may also result in myopic eyes from very slight contusions; it is recognized with the ophthalmoscope as a white mass bulging into the vitreous, often furrowed on its surface and with the retinal vessels running over it. If limited to one segment of the retina, vision may be impaired only in the corresponding part of the field, but not infrequently sight is completely lost.

7. *A peculiar form of retino-choroiditis*, in which there is both atrophy and pigmentation, is liable to come on within a few weeks of concussion of the globe. It may be limited to the yellow-spot region or may be generally diffused, sight being impaired to a corresponding extent. The possibility of this should be borne in mind in giving a prognosis as regards vision after a blow on the eye.

8. *Concussion cataract* is described under Diseases of the Lens (see page 731).

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## SECTION II.—DISEASES.

### DISEASES OF THE CONJUNCTIVA.

The chief of these are: (1) catarrhal or muco-purulent ophthalmia; (2) purulent ophthalmia; (3) granular conjunctivitis; and (4) chronic conjunctivitis without granulations.

#### 1. Catarrhal Ophthalmia.

An acute form of conjunctivitis, attended with more or less discharge of mucus or muco-pus, occurring at all ages, but especially in children and young adults, and decidedly contagious. The cause is often doubtful: exposure to draught is sometimes assigned; the subjects have not uncommonly recently recovered from measles or scarlet fever (especially the former); while sometimes it runs through all the members of a family or dwellers in a house. It appears to be most prevalent in the spring and autumn. The first symptom is a feeling of grit under the lids, with pain and perhaps photophobia; the lids are stuck together on waking in the morning, and when the eyes are examined, the whole conjunctiva is seen to be intensely congested. In strumous subjects especially, phlyc-

nodules or phlyctenular ulcers are met with at the same time, and such cases are slower in their course than the uncomplicated ones, which, as a rule, completely recover in a week or two. Catarrhal ophthalmia can be readily distinguished from the more serious purulent form due to gonorrhœal infection, by the character of the discharge, which in the former disease is rarely profuse, and consists of whitish-yellow sticky mucus; small, conjunctival ecchymoses are often seen at the onset of the attack.

**Treatment.**—A mild, astringent lotion should be used freely to bathe the conjunctival surface three or four times a day, and the edges of the lids should be anointed with some simple ointment (ung. galeni, ung. cetacei, or a very weak ointment of the yellow oxide of mercury) at night-time. Either of the following lotions are useful:—

| | |
|---|---|
| Acidi boracici, | gr. x |
| Zinci sulphatis, | gr. ij |
| Glycerini, | ♏x |
| Aq. destill., or aq. rosarum, | ℥j. |
| Argenti nitratis, | gr. j, or gr. ij |
| Aq. dest., | ℥j. |

or a saturated solution of boracic acid in distilled water.

Photophobia is rarely very pronounced, unless a corneal ulcer is present, but it is well to use a shade for a few days; the common practice among patients of tying the eyes up, or, worse still, of applying poultices, should be forbidden.

## DISEASES OF THE CORNEA.

Being a non-vascular tissue, exposed to various irritants from without, the corneal surface is very liable to inflame and ulcerate, particularly in subjects in weak health, and the several forms of corneal ulcer constitute a large proportion of the total cases observed in ophthalmic practice. Further, the whole substance of the cornea is liable to inflammation, due to inherited syphilis (interstitial keratitis); and some rarer forms of corneal disease are met with secondary to iritis, cyclitis, or complicating granular lids, ophthalmia neonatorum, etc.

We may here mention the impaction of foreign bodies in the cornea, such as fragments of steel or dust. The reaction in these cases is generally severe, pain and congestion coming on rapidly; and in such cases a careful examination should be made of the corneal surface by oblique illumination. The detection and removal of the foreign body is much aided and rendered painless by instillation of cocaine (2 per cent. solution applied a few times at intervals of a minute or two).

The patient's eye being steadied by the surgeon's left index finger pressing on the lower lid, the foreign body may be removed either by a corneal spud or a sharp needle; and it is often advisable to tie the eye up for a few hours after the little operation. If not found on the cornea, each lid should in turn be everted and a thorough search made for the foreign body.

## DISEASES OF THE IRIS.

Very occasionally melanotic sarcomata originate in the iris, cysts may develop in it (sometimes in connection with an eyelash driven into the anterior chamber), and an interesting congenital condition is met with under the name of coloboma of the iris. This consists in an incomplete closure of the iritic circle, the gap being constantly situated in the lower (or lower and inner) part; it may co-exist or not with coloboma of the choroid. Tubercle also occasionally affects the iris, and miliary gummata may form in it, both from acquired and inherited syphilis.

These conditions, however, are all of comparative rarity and slight importance considered with regard to inflammation of the iris—iritis in its various forms.

*Iritis* may be due to one of many causes, the following being the chief; secondary syphilis, rheumatism, injury, inherited gout, and gonorrhœa—the first two being by far the most frequent. In addition we may note struma as a cause, although the expression is, of course, rather vague, and sympathetic ophthalmia includes iritis as one of its manifestations.

Iritis may be acute, sub-acute, or very insidious and chronic in its course, and hence the symptoms may differ in individual cases; the following are the most important:

1. The pupil is not perfectly round, and does not dilate well on shading the eye, or after the application of atropine or homatropine. Small adhesions to the front of the lens are common, giving an irregular outline to the pupil, or deposits of uveal pigment may be noticed within its margin.

2. The iris is altered in color and its reticulated structure somewhat obscured; a greenish or gray hue is the most common, but an originally brown iris does not change much. Often minute vessels can be detected on the inflamed iris, running in toward the pupil, and sometimes nodules of lymph are developed.

3. There is congestion of the conjunctival vessels, a congestion which is not obliterated by gentle pressure; there is more or less intense photophobia, pain in the eye itself, and pain referred to the forehead or adjoining parts. This referred pain, often localized in the distribution of the supra-orbital nerve, is to be accounted for by the fact that the sensory nerves of the iris are derived from the ophthalmic trunk.

Of these symptoms the imperfect action of the pupil to light and homatropine is the most important. Sometimes the tension of the globe is raised in iritis, and secondary glaucoma may be ultimately produced by complete adhesion of the iris to the lens (total posterior synechia), the aqueous being unable to escape from the posterior chamber and bulging the peripheral part of the iris forward (*iris bombé*).

Syphilitic iritis occurs, with the exception of that form sometimes accompanying interstitial keratitis, during the secondary stage, and very rarely relapses. From three to six months after the chancre (in congenital syphilis at the same date from birth) is the usual time of its onset. It often affects both eyes, though commonly after a short interval, and, curiously, it may come on in the second eye whilst the patient is under mercurial treatment for the attack in the other one. It is especially in syphilitic iritis that small nodules of lymph (minute gummata) are met with in the iris, and delicate shreds of lymph may sometimes be seen in the anterior chamber. If treatment be neglected the pupil may become occluded by this lymph and practical blindness result in the affected eye; under mercury, however, in recent cases it is speedily absorbed.

Single large adhesions are very characteristic of specific iritis; in infants it is much more common amongst females than males, and would appear occasionally to develop *in utero*.

Rheumatic iritis comes on, as a rule, during adult life, sometimes from exposure to wet and cold, and generally a history of lumbago or articular rheumatism can be obtained. It is very prone to relapse, and the pain, congestion, and photophobia are more intense than is commonly the case with iritis due to other causes. Tough adhesions to the lens are prone to occur, but nodules of lymph are rarely seen.

*Serous iritis* (or kerato-iritis) is a very chronic form of the disease, characterized by the deposit on the back of the cornea (Descemet's membrane) of a number of minute dots of lymph, arranged in a triangle with its apex toward the centre of the cornea and its base at the lower border. The pain, congestion, etc., are not severe, but it is a very troublesome form of iritis to treat. The patients are commonly women, especially those of strumous tendency; serous iritis may, however, be a symptom of sympathetic ophthalmia. Peripheral choroiditis (in the form of rather faint patches) is present in many if not all cases of serous iritis.

Iritis from inherited gout is insidious but destructive in its nature, and is generally accompanied by inflammation of the ciliary body (cyclitis); the same may be said of iritis due to gonorrhœa or gonorrhœal rheumatism.

**Treatment.**—By far the most important measure in treating any case of iritis (so long as the attack is in the active stage) is to use atropine vigorously. An aqueous solution (four grains to the ounce), or a mixture with ten grains of cocaine in pure vaseline, should be applied within the lids at frequent intervals until the pupil is dilated so far as the case will allow. Recent adhesions will yield to the use of atropine three or four times daily, but the mydriatic has no power over old synechiæ, and its only result is then to cause irritation.

Whilst the use of atropine is most important in all cases of acute iritis, the other measures will vary according to the cause of the disease. In treating traumatic iritis, apply cold to the eye; other forms are more relieved by warm belladonna fomentations, etc. A blister on the temple sometimes relieves the pain, or leeching may be tried in the same situation. Mercury should be given in cases of acute syphilitic iritis, the dose being increased until the gums are touched. The form in which it is prescribed varies much; a convenient one is: two grains of gray powder with one of Dover's powder two or three times a day. Mercurial inunction ensures a rapid effect if performed thoroughly—but is not a cleanly method. In the treatment of rheumatic iritis salicylate of soda (in fifteen-grain doses) is sometimes useful; the bicarbonate and iodide of potassium also appear to do good. Of course, exposure to draught or cold should be carefully avoided, and the affected eye should be protected by cotton-wool and bandage, etc. Dry heat appears to be particularly efficient in easing the pain of rheumatic iritis. Stimulants should be avoided; a brisk purge is often advisable in commencing the treatment, and perfect rest of the eyes in a darkened room and the use of a shade are essential in treating acute iritis. In the more chronic forms, or when several relapses have occurred, a free iridectomy upward is sometimes advisable, one object of the operation being to keep open the communication between the anterior and posterior chambers. It should not, as a rule, be performed whilst any active inflammation is going on, or the aperture made would then be closed again by the effusion of lymph.

In treating serious iritis tonics and iron or cod-liver oil are the most useful medicines, whilst, of course, atropine should be employed locally.

## CATARACT.

This term includes many varieties of opacity of the lens, the prognosis and treatment of which differ greatly: some steadily advancing until the whole lens becomes opaque, others remaining stationary for many years and not preventing a fair amount of vision.

### 1. Pyramidal or Anterior Polar Cataract

consists in a small central opacity on the anterior surface of the lens immediately beneath the capsule; it is nearly always the result of an attack of ophthalmia neonatorum (or small perforating ulcer of the cornea), has very little tendency to advance, and requires, as a rule, no operative treatment. If, however, it be large enough to interfere much with vision an iridectomy performed downward and inward would be indicated.

### 2. Posterior Polar Cataract

often of a stellate form, is situated at the posterior pole of the lens, and is usually found in association with high degrees of myopia, or as a result of a blow on the eye. In the latter case the opacity is often of a curious punctate or wavy outline, and

must be distinguished from the cases of traumatic cataract due to direct wound, in which the whole lens swells and becomes opaque. Posterior polar cataract is usually very slow in progress.

### 3. Lamellar Cataract

is met with in early life, its subjects having nearly always suffered from convulsions in infancy, and frequently presenting what are known as mercurial teeth, *i. e.*, the permanent incisors and canines are worn horizontally in grooves, the enamel being most deficient toward the cutting edges. The theory assigned for this dental malformation is that the mercury given for the convulsions leads to slight stomatitis, which affects the development of the permanent teeth. Besides the incisors and canines, the first molars are liable to show changes, the crowns being deficient in enamel, often presenting fine spicules, and wearing down early. Lamellar cataract consists in an opaque layer between the cortex and centre, both of which remain clear; the lamella affected may be so thin as to be only visible by careful focal illumination when the pupil is dilated, and vision may be but little impaired. If this be the case, no treatment is advisable, but in the majority of cases a needling operation is required. Lamellar cataract is always symmetrical.

### 4. Senile Cataract

is that form coming on, as a rule, after forty-five or fifty years of age; it is always of the hard variety, *i. e.*, suitable for extraction and not for needling operations. It may commence by a number of peripheral opaque striæ, or by a central (nuclear) opacity which slowly involves the rest of the lens. The progress of senile cataract is very variable, though, perhaps, in the majority of cases, it becomes complete within two or three years of its commencement.

Senile cataract is, as a rule, of a white or grayish-white color, but is occasionally amber or (very rarely) brownish-black.

We have also to note that cataract may be secondary to iritis, glaucoma, or other degenerative changes in the eye, that it may occur in a lens dislocated by injury, or in connection with advanced diabetes mellitus. None of these forms are at all favorable for operation.

**Symptoms and Treatment of Cataract.**—The first symptom of commencing cataract is dimness of vision, both for near and distant objects, and the opacity is best recognized by oblique illumination in a dark room. Peripheral striæ may only be detected if the pupil be first dilated with homatropine, etc. As already stated, the rate of progress is very variable, and hence it is well not to alarm the patient by using the word "cataract" in the early stage. So long as one eye retains sufficient vision to enable the patient to work, any operation should be deferred. A senile cataract is considered to be ripe or ready for operation when the whole lens has become opaque; this is best estimated by observing whether during oblique illumination the iris shows a shadow or not on to the opaque part, *i. e.*, if there is still a clear part between the iris and the opacity. But there are other points to be ascertained before recommending operation. Any condition of bad health, or the existence of inflammation of the lachrymal sac, requires to be treated before extraction can be justifiably undertaken. In the case of the latter, the presence of muco-purulent discharge at the time of operation would be almost certain to lead to suppuration of the globe. Then, in a case suitable for operation, the pupil should contract to light, and the patient should be able to detect the position of a lighted candle held a few feet away at various parts of the field of vision. These tests show roughly that the retina is not diseased. Cataract in highly myopic patients is not very favorable for operation, since it is often accompanied by abnormal fluidity of the vitreous, which will tend to escape at the time of operation, and by degenerative changes in the retina and choroid. (For the various operations on cataract, see p. 740.)

## GLAUCOMA.

The essential feature of this disease is *increase of tension* in the globe, and we may have such increase of tension resulting from iritis, swelling of the lens in traumatic cataract, etc., when it is called secondary glaucoma, or occurring without obvious cause, when it is termed primary glaucoma. But the most important division is into the chronic and acute forms, for not only do some of the symptoms differ, but the treatment also.

There is in the normal eye a constant passage of fluid from the angle of the anterior chamber into the adjoining venous channels (canal of Schlemm, etc.), and there is no doubt that one frequent cause of glaucoma is an obstruction to the filtration at this spot. A good instance is afforded by the attack of glaucoma which occasionally is brought on by the use of atropine in elderly subjects—the mydriatic, so to speak, forcing the iris into the angle of the anterior chamber: such an attack, as a rule, is cured by the use of eserine, which, by contracting the pupil, draws the iris away from the angle. Glaucoma is more common after middle life than before, and we may associate with this the fact that as age advances the lens becomes relatively larger and may therefore help in causing obstruction to the outflow (Priestley Smith). There is, however, a curious form of glaucoma known as buphthalmos, met with in children, in which the whole eye is enlarged, hard, and the anterior chamber deeper than normal. Chronic inflammatory processes at the ciliary region are also an important cause of glaucoma.

### 1. Acute Glaucoma

is much more common amongst women than men, and is especially prone to occur after the age of forty-five. Whilst no cause can be assigned in many cases, in some it appears to be due to excessive use of the eyes, severe mental emotion or shock. The subjects are nearly always hypermetropic, acute glaucoma being decidedly rare in myopic eyes. Certain premonitory signs often precede the acute attack: rapid increase of presbyopia, passing congestion of the eye, colored rings seen by the patient around a distant light, being the usual ones. The sight then becomes rapidly worse, the patient complains of seeing objects obscured as though by a fog, there is intense pain in the eye and forehead, and frequently sickness accompanies the pain. On examining the eye, marked congestion, with often œdematous swelling of the conjunctiva (chemosis) is found, the pupil is somewhat dilated and responds badly to light, the anterior chamber is shallow (as a rule), the media hazy. The cornea may be so "steamy" that no view of the fundus can be obtained; but, if the disc can be seen, the veins are found to be engorged, and there is arterial pulsation. The visual field is much narrowed, the inner side going first.

Mistakes in diagnosis are often made, the sluggish pupil suggesting iritis, or the congestion and chemosis may be thought to be simple conjunctivitis, or the vomiting and headache may be mistaken for a "bilious attack." The essential point in the diagnosis consists in estimating the tension of the globe: this is done by placing the two index fingers on the upper lid as the patient looks down; gentle downward pressure is then made with one finger, and the resistance of the eye felt by the other. Some surgeons use the index and middle finger of one hand in estimating tension. The two eyes should always be tried, and only practice will enable the student to estimate slight degrees of increase. In acute glaucoma, however, the abnormal hardness of the globe is very easily recognized.

**Prognosis and Treatment.**—If acute glaucoma be neglected, the eye becomes rapidly and permanently blind. Irretrievable damage to the retina may be done in a few days; on the other hand, if the disease be early recognized and treated, a most satisfactory result is usually obtained. As soon as possible a free upward iridectomy should be performed (see p. 739), though as a temporary measure eserine drops (two grains to the ounce) may be used. Eserine (and pilo-

carpine to a less extent) has a great effect in reducing tension of the eye, and in a few cases its use may obviate the necessity for operation; but it may be repeated that the treatment for acute glaucoma is iridectomy, which is often followed by complete and permanent restoration of sight. In many cases, however, only partial success results from the operation, because it has been too long deferred, and in a few severe retinal hemorrhage follows it, or the glaucomatous symptoms may recur after a time.

### 2. Chronic Glaucoma

comes on gradually and is characterized by less congestion of the eye, pain, etc., than the acute form. The pupil may be but little dilated and the media may be fairly clear, the disc in an advanced case is seen to be deeply cupped (the vessels curving sharply round its margin) and atrophied. Venous (and with slight pressure on the globe, arterial) pulsation is present in the vessels of the disc. The field is either concentrically contracted or irregularly limited—especially on the nasal or inner side. Attacks of "fog or mist before the eyes" and of halos round a light are often complained of, and the sight steadily deteriorates. The rate of progress is, however, very uncertain in different cases.

The treatment consists in avoiding over-use or strain of the eyes; the patient should be provided with proper glasses; tonics and laxatives may be useful, and a weak solution of eserine (⅛ to ½ grain to the ounce) should be dropped into the eye once or twice daily. Pilocarpine (one to two grains to the ounce) may be used instead of eserine. By these means a patient with chronic glaucoma may retain moderate vision for a long time, but in some cases the best chance is offered by a free iridectomy. If the tension should continue or return, a second iridectomy or a sclerotomy may be useful. It is necessary that the patient's age and state of health should be taken into account before recommending operation, especially as chronic glaucoma is prone to occur in those who are of feeble or worn-out constitution.

One danger of the operation may here be mentioned—that of wounding the lens—in which case a traumatic cataract will inevitably follow. The risk of it is much less if a Graefe's knife be used instead of a keratome.

## DISEASES OF THE CHOROID.

We have to consider briefly: (1) tuberculosis and (2) tumors of the choroid.

### 1. Tubercle of the Choroid

is distinguished by the ophthalmoscope as ill-defined, light, raised patches, as large as, or larger than, the optic disc. It is nearly always a sign of advanced general tuberculosis, especially when the meninges of the brain are affected, and is decidedly a rare affection.

### 2. Tumors of the Choroid.

Melanotic sarcoma is the most frequent primary growth, and there is the same tendency to rapid general infection through the blood as in melanotic sarcoma starting in the skin. Nevertheless, if the eye containing the tumor be excised early, a radical cure is possible. These sarcomata are composed of spindle and round cells, occasionally non-pigmented; in all cases the tumor tends to project into the vitreous, as well as to invade the sclerotic and orbital tissues. Glioma, starting in the eye, grows backward along the optic nerve to the brain, and is more common in childhood than is sarcoma of the choroid. The latter may be recognized ophthalmoscopically, before it has protruded through the sclerotic; it

often commences at or near the ciliary region, and pushes the iris somewhat forward, while increasing the tension of the globe.

Excision of the eye is the only treatment, and the earlier it is done the greater the chances of non-recurrence.

## DISEASES OF THE EYELIDS, ORBIT, ETC.

The lax tissue of the eyelids is especially prone to œdematous swelling, sometimes the remains of an attack of facial erysipelas, more often a sign of general ant of tone, of senility, or of more serious visceral disease. Occasionally we eet with persistent œdema of the lids for which no cause can be assigned, or hich has started in some long past erysipelatous affection. Abscess of the lid is a t uncommon complication of facial erysipelas, and should be incised as early as ssible; occasionally it is due to an embedded foreign body. There is considerle risk of an orbital abscess finding its way backward into the skull, and sudden ath may result from this, hence the importance of opening and draining any llection of pus in this situation. An exploration can readily be made with a arp tenotome introduced parallel to the orbital roof or floor.

### BLEPHARITIS (OR SYCOSIS) TARSI

the name given to inflammation of the lid margins of an eczematous nature. here may be small ulcers along the lid borders, or simply pustules and crusts, e hairs tending in old cases to atrophy and fall out. In some cases the hairlbs form the centres of small pustules, and it is for these that regular epilation ith forceps is advisable; when the blepharitis is more of an eczema than a sycosis may usually be cured without resorting to this painful measure.

The disease is most common in children, often follows an attack of measles scarlet fever, and is very chronic in its course. It may also be set up in adults prolonged overwork of the eyes in ill-ventilated rooms, and sometimes is associated with uncorrected errors of refraction.

There is more or less gummy discharge and lachrymation, the lids adhere gether on waking up, and the condition is aggravated by exposure to cold winds, c. A large proportion of its subjects are anæmic or show signs of scrofulous ndencies. The treatment is satisfactory if the case be seen early, but when epharitis has existed for long it becomes well-nigh incurable. All scabs should removed twice a day by free bathing with warm water (or a lotion containing e or ten grains of bicarbonate of soda to the ounce), and a stimulating ointment he ung. hydrarg. nit. dil., or the ung. hydrarg. oxidi flavi) applied to the edges the lids. Sometimes an astringent lotion (see treatment of conjunctivitis) suits ell, and the application of a twenty-grain solution of nitrate of silver from time time may be useful. Any decided error of refraction should be corrected; if ere is photophobia, the use of cobalt-tinted protective glasses, or of "goggles," advisable. Cod-liver oil should be given in the strumous cases and preparations iron in the anæmic ones. Sometimes, as already mentioned, it is necessary epilate or to apply the mitigated nitrate of silver stick from time to time to the tle sores.

### LACHRYMAL OBSTRUCTION.

The chief symptom of impeded passage of tears into the nose is *epiphora*, or eir flowing over the cheek. The obstruction may be situated at the puncta (or e latter may be displaced, owing to entropion or ectropion), in the canaliculi, chrymal sac, or nasal duct. If it is in the latter, pressure over the sac with e finger will cause a sudden regurgitation of fluid (more or less mucoid or even rulent) through the puncta. This distention of the sac (*mucocele*) by retained ucus and tears can often be seen as a rounded swelling at the inner canthus; it

is always liable to set up inflammation and suppuration, and if the abscess is allowed to burst it commonly does so below the tendo oculi. A fibrous stricture of the nasal duct is not infrequently the cause of lachrymal obstruction, being itself probably due to some chronic inflammation of its lining mucous membrane. Disease of its bony wall (*e. g.*, from inherited syphilis) may also give rise to most intractable lachrymal obstruction.

In cases of chronic conjunctivitis with epiphora, but without mucocele or other evidence of organic obstruction, astringent drops or lotion (two grains of nitrate of silver or sulphate of zinc, or one grain of chloride of zinc to the ounce) are of use. If there is displacement of one or both puncta or narrowing of the duct, considerable advantage is gained by slitting up the canaliculus with a Weber's probe-pointed knife. The lachrymal duct can then be explored by probes, any stricture dilated, and frequent irrigation employed. It must, however, be admitted that the gradual dilatation of these strictures is commonly very unsatisfactory, even when aided by the frequent use of astringent and antiseptic lotions, and somewhat better results are obtained from introducing a leaden style (the upper end of which is bent down so as to prevent it slipping right in), which is worn for many months at a time. Boracic or weak sulphate of zinc lotion should also be used.

### Syphilitic Affections of the Lids.

Primary chancres are occasionally met with both on the conjunctival and cutaneous surfaces; they are always accompanied by pre-auricular or submaxillary buboes, the presence of this gland-enlargement assisting greatly in the diagnosis. During the secondary stage, especially if there is a well-marked eruption on the face, a syphilitic form of blepharitis with multiple small ulcers along the lid-borders is sometimes observed. Tertiary ulceration of the eyelids is noteworthy from the fact that it is difficult to cure by the ordinary treatment (iodoform locally and iodides internally), and is very prone to relapse. It is a rare disease, the subjects being usually women who have suffered severely from other syphilitic symptoms.

### Tumors of the Eyelids and Orbit.

By far the most common is what is known as a *meibomian cyst* or *chalazion*. It occurs (usually in young or middle-aged adults) as a small, rounded, well-defined lump in the eyelid, which really starts in the meibomian gland layer, but tends to

Fig. 316.—Beer's Cataract Knife.

project most toward the skin. Sometimes more than one is present at the same time, and there is a tendency for them to recur in certain individuals. They consist of a gelatinous mass of small cells situated around one of the meibomian glands, and, though they may sometimes long remain quiet, tend, as a rule, to inflame and suppurate. Hence it is advisable to operate on them as soon as they attain a sufficient size to be easily recognized by the finger passed over the affected lid. The latter should be everted, the conjunctival surface over the tumor treated with pure cocaine to procure anæsthesia, then a small, crucial incision made with a Beer's knife, and the little tumor evacuated by means of a small curette and finger pressure. If the cyst has already suppurated, an incision alone will suffice.

A *stye* consists in inflammation and suppuration about one of the sebaceous glands at the edge of the lids. As is the case with meibomian tumors, there is usually a strong tendency to recur. Hot fomentations and a small incision,

st the pus, constitute the local treatment; any accompanying conjunctivitis or ror of refraction should be attended to, and a tonic is often useful.

*Horns* are occasionally seen growing from one or other eyelid; they invaiably originate in a sebaceous gland, and, however hard toward the apex, are irly soft at their base. Excision with scissors is required.

*Nævi* are common about the eyelids as elsewhere on the face; the cutaneous urple ones should be treated with a very fine cautery point (the galvano-cautery ire-loop is suitable), or by electrolysis. The advantage of the latter is the subsequent absence of scarring, but it is a slow and rather uncertain method. The most difficult form to treat is the large subcutaneous venous nævus, which may cause the affected yelid to constantly project over the eye. Repeated unctures with the fine point of the Pacquelin's autery form the most satisfactory treatment, an interval of a few weeks being allowed between each pplication.

FIG. 317.—A Small, Melanotic Growth on the Lower Eyelid, commencing in a mole.

A form of congenital growth occasionally met ith at the edge of the eyelids is the pigmented ole, forming a small, lobulated excrescence. It is importance from the risk of melanosis starting from it in later life, and hence ould be excised.

*Molluscum contagiosum* is treated in the section on *Diseases of the Skin.* A vorite starting-place for *rodent ulcer* is the inner part of the upper or lower eyel. It commences as a small, smooth infiltration of the skin, and tends to have crescentic outline and to ulcerate sooner or later, then steadily advancing both depth and on the surface. It may occur as early as thirty years of age, but is ost common in more elderly patients, and, as is well known, causes no glandular largement, however long it exists.

The best treatment is excision, scraping or cauterization being more likely to followed by recurrence, unless very thoroughly done.

*Dermoid cysts* occur as rounded, subcutaneous tumors, especially over the ternal angular process of the frontal bone, which is often slightly indented neath them. They are always congenital, and due to peculiarity in development, and do not, as a rule, increase much after the first year or two. They have fibrous wall lined with epithelium, their contents being chiefly sebaceous matter, olesterin, and abortive hairs. If prominent enough to be unsightly, the cyst ould be excised (without opening the cyst-wall during the operation, if it can avoided), the wound being made parallel to the eyebrow, and carefully sutured ith fine silk. A spirit lotion or iodoform should be used in the dressing.

### PULSATING ORBITAL TUMOR.

This term includes several conditions, producing the following symptoms: ) protrusion of one eye (occasionally of both), with dilatation of its superficial in; (2) pulsation to be felt in the orbit, generally best through the upper lid; ) a continuous bruit, which is not only readily heard by the surgeon, but gives eat annoyance to the patient; (4) frequently paralysis of one or other oculootor muscle. Although the pathology of this affection is still not completely certained, it is certain that the most usual condition is a great dilatation of the phthalmic vein (due in most cases to a communication with the internal carotid tery in the cavernous sinus).

More rarely a true aneurysm of the carotid or ophthalmic arteries is present.

Pulsating orbital tumor, like arterio-venous aneurysm elsewhere, is generally e result of injury—a fall or blow on the head involving fracture of the base, a nctured wound of the orbit with a sword or stick, etc.—and is, therefore, most mmon in males. It develops gradually within a few weeks of the injury, the

symptoms increasing in severity until sometimes vision is lost, owing to the extreme protrusion of the globe and stretching of the optic nerve. In some cases it arises independently of any injury, and this spontaneous form is usually of sudden onset, and is most common in females.

It is an interesting fact that, however great be the protrusion (*proptosis*) the vessels of the optic disc present but little that is abnormal, beyond pulsation of the veins. As already mentioned, however, the veins of the conjunctiva and lids are usually much dilated.

The progress of the disease is variable; a gradual diminution of the protrusion and spontaneous cure is possible, though most of the cases are submitted to treatment. This consists in: (1) digital compression of the common carotid, which unfortunately can only be carried out for short periods, owing to the pain it causes; (2) the use of ice or graduated compression over the globe and eyelid; (3) ligature of the carotid artery. Attempts have been made more than once to ligature the dilated vessel in the orbit, but have almost always failed.

Tying the common carotid has been followed by cure in a fair proportion of cases, but it is a proceeding attended with serious risk, and should not be resorted to, unless milder measures have failed, and the symptoms are steadily increasing in severity.

## OPERATIONS.

The introduction of cocaine has greatly limited the use of ether and chloroform in ophthalmic surgery; general anæsthesia is now only required, as a rule, for excision of the globe, tenotomy in young children, advancement of a rectus, and iridectomy for glaucoma. Extraction of cataract can nearly always be effected under local anæsthesia, and thus the risk of after-vomiting avoided, but occasionally it is necessary to give ether or chloroform if the patient be very restless or possess no self-control. To obtain local anæsthesia of the cornea and ocular conjunctiva, the best way is to drop on to them a 2 per cent. solution of freshly prepared cocaine (made with some boracic acid in it for the purpose of antisepsis) several times during the ten minutes which precede the operation. It must be remembered, however, that the cocaine does not anæsthetize the lid-borders nor the iris, hence the introduction of a speculum and iridectomy cause slight pain. In doing extraction of cataract with iridectomy, it is well to warn the patient of this before introducing the iris forceps, for fear that a sudden movement should endanger the success of the operation.

Hypodermic injection of a few drops of cocaine solution may be used in performing tenotomy or excising part of the eyelid, etc.; and, for the removal of a meibomain tumor or applying astringents to the conjunctiva, anæsthesia is best procured by applying powdered cocaine and allowing it to dissolve locally.

### 1. Excision of the Globe.

Instruments required: spring speculum, fixation forceps, scissors curved on the flat, strabismus hook. Standing behind the patient, introduce and fix the speculum, pick up the conjunctiva just above the cornea, and divide it all round close to the sclero-corneal junction. Having opened Tenon's capsule, introduce the hook under each of the recti muscles in turn and divide them. Then open the speculum as widely as possible, press it backward and make the globe protrude. Steadying it with the fingers of the left hand, introduce the scissors behind the globe from the right-hand side, open them to receive the optic nerve within the blades, and divide it with a single cut. One or both oblique muscles and some connective tissue may still require to be divided. A small sponge should be at once applied and kept in place by a pad and firm bandage. The wound heals usually within a week, and about a month after the operation a glass eye may be worn. It is well to use some boracic lotion and ointment daily for a week or two after the operation.

Lately the introduction of small celluloid, glass or silver globes within Tenon's capsule, to take the place of the excised eye, has been extensively tried. The capsule and conjunctiva should be sewn up separately with fine silk, and it is well to use a drain of horsehair for a day or two. If the operation succeeds, the movements of the glass eye are generally improved by the presence of the globe behind it, but, unfortunately, there is a strong tendency on the part of the latter to work out.

A glass eye should be removed every night and cleansed, and it needs to be renewed, as a rule, once a year.

### 2. Tenotomy.

(The common operation—division of the internal rectus—will be described.) The operator stands at the right side of the patient, introducing the speculum, and seizes a little fold of conjunctiva with the fixation forceps—the point aimed at being the junction of the inner and lower corneal tangents. With a small pair of straight scissors he makes an opening in the conjunctiva and Tenon's capsule at the same time. If this is not done, the capsule should be picked up separately and incised. The strabismus hook (which should always be blunt-ended) is now passed with its head directed backward toward the apex of the orbit, then brought under the rectus tendon, and the latter slightly raised on the hook, whilst one blade of the scissors is introduced under it, the other passing between the conjunctiva and tendon. The latter is now cut through, and the hook may be reintroduced if it is thought some part of the muscle has remained undivided. A pad and bandage are usually applied for a few days—the conjunctival wound is so small that no suture is required.

It is never advisable to perform tenotomy on both eyes at a time, for fear divergence should result. Squints of 25° or more will not be cured by a single tenotomy; but it is best to perform the second operation after a considerable interval; of course, all errors of refraction should be corrected.

Sometimes tenotomy of one muscle is combined with advancement of its opponent, *e. g.*, for divergent strabismus the external rectus is divided and the internal one advanced. The operation of advancement is too complex to be described here.

### 3. Iridectomy.

As already described (p. 728), in cases of wound of the globe with prolapse of the iris, an iridectomy may be required. Apart from this it is performed

Fig. 318.—Iridectomy Downward and Inward for Artificial Pupil.

Fig. 319.—Iridectomy for Glaucoma. (*De Wecker.*)

either for optical purposes (*i. e.*, to provide an artificial pupil in cases in which the natural one is hidden by a corneal nebula or obstructed by lymph) or to facilitate the extraction of cataract. In either case only a small iridectomy is generally made. But in the case of iridectomy for glaucoma it is necessary to remove a large portion of the iris and take it right up to the ciliary attachment (see Fig. 319).

Iridectomy for optical purposes is made by choice downward, or downward and inward; but its position must, of course, depend on that of the clear part of the cornea. Iridectomy for glaucoma is nearly always performed upward, so that the coloboma may be concealed, to some extent, by the upper lid. In doing the former, a keratome is usually employed, whilst many prefer Graefe's knife for the

latter operation. There is a certain amount of risk in using the keratome that the lens capsule may be wounded, though this does not often happen.

The operation for glaucoma may be briefly described. An anæsthetic is advisable. The speculum having been introduced, the conjunctival surface is cleansed with boracic lotion. The operator, standing behind the patient, fixes the globe by grasping the conjunctiva with the forceps below the cornea, and then with a broad keratome or a Graefe's knife makes an incision about 1 mm. behind the sclero-corneal junction, equal to nearly one-third of the corneal circumference, and just in front of the attachment of the iris. The instrument is slowly withdrawn, the escape of the aqueous causing the iris to bulge toward the wound. A pair of iris-forceps is now introduced, opened, and made to seize the iris toward its pupillary border, the assistant having taken charge of the fixation-forceps. The iris is now drawn out and cut through at the right-hand margin of the wound; by gentle traction it is torn away from its ciliary attachment as far as the left-hand border of the wound and again divided. A fine caoutchouc spatula or curette is now used to depress either border of the iris from the wound, any blood is gently wiped away with cotton-wool pledgets, a drop of eserine solution applied, and the speculum removed cautiously. The eye is kept bandaged up for several days, sal-alembroth wool and gauze being used for the dressing. It should be removed daily, the lids bathed, and the dressing reapplied.

*Complication of the Operation, etc.*—Owing to the anterior chamber being generally very shallow in acute glaucoma, it requires considerable skill to make the section behind the sclero-corneal junction and yet in front of the iris. On account of the tension a sudden spurt of aqueous, as soon as the section is made, is very liable to occur and to increase the risk of wound of the lens.

The dilated blood-vessels of the conjunctiva bleed readily during the section, and it occasionally happens that the sudden relief of tension is followed by profuse intra-ocular hemorrhage, destroying vision and rendering subsequent enucleation necessary.

### 4. Needling Operations for Soft Cataract.

These are only suitable in early life, and are used chiefly for lamellar or congenital cataract. It may be necessary to give an anæsthetic, though cocaine will often suffice. The pupil should be fully dilated with atropine before the operation, and its use continued during the whole process of swelling up and absorption of the lens matter, this often taking many weeks. The lids being either held open or kept so by a speculum, a cataract needle is introduced through the cornea near its margin and directed toward the centre of the pupil; its point is then turned backward and made to tear the capsule and front of the lens. The needle is withdrawn, taking care not to touch the iris. It is well to use ice-water dressing for forty-eight hours, and to keep the patient in a darkened room (Nettleship). The lens matter, if exposed to the action of the aqueous humor, swells and projects into the anterior chamber, and is slowly absorbed. After a month or two, if no irritation or congestion is present, the needling may be repeated, and sometimes three or four operations are required.

Some operators prefer to hasten the process by needling freely at first, and when the lens has become swollen and softened, letting it out through a small incision made with a narrow keratome, either by the curette and slight finger-pressure, if required, or by the use of a special suction instrument. Of course, after the cataract has been removed, the patient will require convex lenses to read with—about 10 D to 12 D for distant vision, about 16 D to 18 D for near vision.

### 5. Extraction of Hard Cataract.

The operation generally performed is what is known as a modified Graefe's extraction, the narrow knife named after that surgeon being used, and the section lying chiefly at the sclero-corneal junction.

Frequently a small upward iridectomy is performed some weeks or months before the removal of the cataract, and this proceeding, though it involves two operations, appears to increase the chance of the result proving satisfactory. If preliminary iridectomy is not done the proceeding is as follows: the eye being under the full influence of cocaine, and a boracic solution having been used to render the conjunctiva aseptic, the speculum also being in place, the operator fixes the eye as already described (see *Iridectomy*) and introduces the knife with its point directed toward the centre of the pupil, at or just behind the sclero-corneal junction. As soon as the blade is well in front of the iris the handle is depressed and the point carried across to emerge at a point corresponding to the one of entrance. The puncture and counter-puncture are so placed as to include between them about two-fifths of the corneal circumference. The incision is then completed by to-and-fro action of the knife, the edge of which is turned somewhat forward as it cuts through. Care should be taken not to press upon the globe with the fixation forceps, which simply effect gentle downward traction. The iris forceps is now introduced, the upper part of the iris drawn out and removed by a single cut of the scissors (the amount removed being much smaller than is necessary for glaucoma). The cystotome is then passed into the anterior chamber, its point turned toward the lens and made to tear through the capsule transversely (some operators add a vertical division of the capsule). By steady pressure with a curette, placed at the lower border of the cornea, the lens is now made to tilt forward and to present in the wound. The pressure is relaxed as soon as the greatest diameter of the lens has emerged, for fear of escape of vitreous. Frequently some manipulation with the finger through the lower lid is finally needed to coax out bits of lens cortex which have remained.

The margins of the iris should now be depressed away from the wound if they tend to protrude, and after it has been ascertained that the edges of the wound lie in good apposition, the upper lid should be cautiously lifted over it and the closed eyes bandaged up with a four-tailed bandage.

It should be noted that before bringing pressure on the globe to extract the lens the speculum should be relaxed or held forward by the assistant.

*After-treatment.*—The patient is usually kept in a darkened room for about a week, the bandage changed and the lids bathed once or twice daily, and atropine used if frontal pain, etc., suggests the onset of iritis. Leeches to the temple are also advised by some surgeons in the latter case. At the end of a fortnight, if all goes well, the patient may go about with protective goggles, and a few weeks later be tested for glasses.

*Complications, etc.*—Escape of vitreous is much to be dreaded if the incision be made too far back, in myopic eyes, etc. Should it occur before the lens projects the scoop should at once be introduced and the lens drawn out with it. The operation should in any case be brought to a speedy close and the eye bandaged up.

In a certain small proportion of cataract cases the eye suppurates, or becomes the seat of severe iritis. In a great many it is necessary to perform subsequent needling operations for the removal of opaque capsule.

# CHAPTER X.

## *INJURIES AND DISEASES OF THE FACE AND NOSE.*

### MALFORMATIONS.

Malformations of the face result from imperfect development or incomplete fusion of the median (fronto-nasal) maxillary or mandibular processes. They may affect the soft parts only, the bones being properly formed beneath, or the soft parts and the bones as well.

Hare-lip, which is by far the most common, is due to the failure of union between the margins of the maxillary and fronto-nasal lobes. It may occur on one side only (and then nearly always upon the left) or on both, and there may be merely a notch on the red margin of the lip, or a deep wedge-shaped defect,

FIG. 320.—Double Hare-lip.

or a complete division extending into the nose. In this last case there is always at the same time a defect in the alveolar border, usually between the middle and lateral incisor teeth; and in many instances the palate is imperfectly developed as well.

When the hare-lip is double and extends into the bone on both sides (a condition always associated with cleft palate) the extremity of the fronto-nasal process, carrying the two premaxillary bones, with the germs of most of the incisor teeth, is completely detached from the maxillæ and often from the vomer, so that it remains suspended from the column, and sometimes from the tip of the nose (Fig. 320).

In comparison with this, other malformations on the exterior of the face are very rare. The maxillary sometimes fails to unite with the mandibular process, so that the mouth is prolonged upward toward the ear (macrostoma); the lachrymal cleft may remain open, and a median fissure may make its appearance in the fronto-nasal process, between the two premaxillary bones. Supernumerary auricles are not uncommon, and are often associated with macrostoma. Similar growths of smaller size may be met with in the neck at the sites of the second and third branchial clefts.

**Treatment.**—The operation for hare-lip has been performed within a few hours of birth. As a rule it is advisable to wait until the child is a month or six weeks old, and in complicated cases later still. Chloroform should be used as the anæsthetic, and the assistant who fixes the head should at the same time compress the facial arteries where they pass over the lower jaw. Sometimes it is advisable to secure the coronaries as well, either with the finger and thumb, after the lip has been detached, or with a pair of forceps, the blades of which are guarded with

rubber. It is convenient to wrap the child round in a towel so as to prevent any movement if the anæsthesia is not sufficiently long.

The lips are first thoroughly freed by dividing the folds of mucous membrane keeping the knife close to the bone. Then the edges are pared, the opposing red margins removed, and the raw surfaces brought together in such a way as to maintain the border line of the lip as accurately as possible.

Where the cleft is incomplete, Nélaton's incision is the best. The angle of

FIG. 321.—Operation for single Hare-lip when the Fissure does not extend into the Nostril.

each flap is grasped in turn with a pair of forceps and a Λ-shaped incision made above the cleft, the length of the two sides depending upon the degree of deformity. A silk ligature is then passed through the incision and drawn downward; this inverts the flap and brings together the opposing surfaces, which may be at once secured with sutures. A slight projection is left on the border of the lip, but it soon disappears. The vertical cicatrix after the operation for hare-lip has a strong tendency to contract, and if the red line is accurately

FIG. 322.—Operation for Single Hare-lip when the Sides of the Fissure are Unequal.

adjusted in the infant there is almost sure to be a notch in the adult. This operation is sometimes performed at puberty to rectify the defect left by a previous one.

The same incisions are made when the cleft is complete, if the two sides are fairly equal. The apex, of course, is wanting, and the two are separate above as well as below. The flaps reflected from the margins are turned down in the same

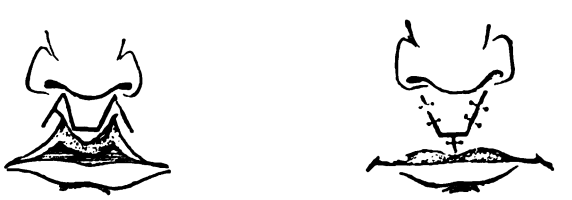


FIG. 323.—Operation for Double Hare-lip.

way, but the whole length is not required and should not be preserved. This is sometimes known as Malgaigne's operation.

If the two borders are very unequal—one, for example, short and vertical, the other long and sloping—a further modification is advisable. The flap on the sloping side is completely cut away; that on the vertical, on the other hand, remains attached at its lower extremity, and is turned down so that it lies under

the cut surface of the other. For this to succeed; the lips must be thoroughly freed and the flaps thick and substantial.

Double hare-lip is more serious. If the intermaxillary bones are in their proper situation and the median portion is well developed, the difficulty is not very great. The sides and lower border of the central projection must be freely pared, the whole of the red border being removed, and two flaps must be fashioned, one on each side, from the lateral portions, so that they may meet each other in the middle line, below the median. To secure a good result, both sides must be done at the same time.

The intermaxillary bones, even when they project as far forward as the tip of the nose, should always be preserved if they possibly can. It is true, the incisor teeth rarely or never develop properly, and that it adds greatly to the difficulty of securing primary union, but, if the part is removed, the upper lip sinks inward so as to produce a most unpleasing effect. In many cases it can be pressed back. If this cannot be done, or if it tends to come forward again, the septum may be broken by grasping it with the blades of a pair of forceps (guarded with rubber) and twisting it. If this does not succeed, a triangular portion of the cartilage behind it may be excised, a longitudinal incision being made along its lower border, and the soft parts carefully separated on either side, so as to preserve the blood-supply intact. In any case, it is advisable to secure it in its proper position by means of a chromic gut suture passed through the maxilla, as the least pressure forward prevents the soft parts uniting; and sometimes this may be done with advantage a week or two before the lip is touched. There are, however, a few cases in which the defect is so great, involving the nose as well, that the bones must be sacrificed (not the periosteum, which can be left intact), and the soft parts used as a support for the hip. The cleft in this case is closed by the lateral flaps alone.

Silk-worm gut should be used for the sutures, one of which should be passed through the margin; another, if possible, from the mucous surface; the rest, as many as may be required, must be inserted through the skin. Hare-lip pins are to be avoided; the coronary artery can be secured, and accurate adjustment maintained as well with ordinary sutures, without the risk of leaving such scars. The wound may either be left exposed to the air for a minute or two, that the discharge may dry upon it, or dusted lightly with iodoform. Collodion is liable to cause great smarting. If the lip is properly separated from the bone beneath, there is very little tension on the parts. To prevent the muscles interfering with union, two pieces of strapping, cut in the shape of a banjo, should be applied, one to each cheek, and then, while the tissues are rolled up together under the nose by the pressure of the finger and thumb, the tails should be secured across the front, slipping one through a slit in the other. The same precaution should be adopted when the wound is dressed, the head of the infant being held between the knees, while the nurse, seated in front, supports the body and holds the limbs. Many kinds of trusses and supports have been devised to hold the cheeks together, but none of them are thoroughly satisfactory, and I have seen children with great scars upon their cheeks caused by sloughing.

The sutures are removed upon the second day; deep ones passed through the bone may be left longer, and if of catgut need not be interfered with. Even if primary union fails, the gap may be bridged across by granulations, but the cicatrix is very conspicuous. The child must, of course, be kept quiet; it may be allowed to take the breast as usual, but should not retain a rubber teat constantly in its mouth, and care must be taken to keep the nostrils clear with a camel's-hair brush and vaseline.

# INJURIES AND DISEASES OF THE FACE.

## Wounds.

Owing to the abundant supply of blood, wounds of the face heal very rapidly. In burns, however, and in gunshot injuries in which there is much loss of tissue, great care is required to prevent deformity; the lower lip, for example, may be drawn down to the neck, or the lower eyelid permanently fixed in a position of ectropion. Even when they are badly bruised, the edges should always be brought accurately together and fastened by sutures: fine silver wire or silk-worm gut if the depth is not great; hare-lip pins, if, for instance, the lip is divided through into the mouth. It is essential to bring the scar into such a position that it will have the least effect upon the eyelids and the mouth. A double set of sutures is sometimes advantageous, one through the mucous and the other through the cutaneous surface; and the latter may be subcuticular, *i. e.*, carried through the corium from side to side, without appearing upon the surface. In this case fine catgut must, of course, be used. Bleeding generally stops of itself, or as soon as the surfaces are brought into apposition; but the facial artery may require twisting or tying. Sutures should be removed as early as possible, and the edges of the wound supported by pressure, so as to avoid scarring. Many instances are on record of large portions of the nose having united again after being completely detached.

## Fractures

of the bones of the face are dealt with elsewhere. They are very frequently compound and comminuted; but extensive necrosis is unusual, and the prognosis, so far as life is concerned, is very good, unless the base of the skull (the roof of the nose, for example) is involved. Accurate apposition, however, so as to avoid deformity, is often a matter of great difficulty.

## Foreign Bodies in the Nose.

Pebbles, dried peas, pieces of slate-pencil, and the like, are often pushed up the nose by children, and frequently, before the case is seen, are driven out of sight by ill-advised attempts at removal. With a proper light there is generally but little difficulty in laying hold of them from the front with polypus-forceps; but in many cases an anæsthetic is advisable, as it may be necessary either to push them back into the pharynx, or to pass the fingers round the soft palate into the posterior nares. In the case of adults, a recurrent stream of warm water may be used, and a sufficient degree of anæsthesia obtained by brushing the surface over with a 5 per cent. solution of cocaine. It must always be remembered that a pointed foreign body, such as a sharp piece of stick, is very easily driven through the cribriform plate.

## Division of the Parotid Duct

is liable to be followed by salivary fistula, the opening of the cutaneous surface persisting, and the whole or greater part of the secretion pouring on to the skin, and giving rise to great discomfort and annoyance. To avoid this, the wound, if it does not already extend into the mouth, should be completed, and a catgut suture passed through the mucous membrane of the cheek and the adjacent wall of the duct on either side, and knotted on the oral surface. The edges of the wound in the skin must then be brought together accurately, and rendered as secure as possible with collodion. Even if union does not take place at the first, the opening has a strong tendency to close, if only the saliva can find its way into the mouth.

## Affections of the Face.

*Facial Carbuncle.*—A peculiar form of carbuncle, caused, probably, by direct inoculation from some foul and putrid source, is occasionally met with upon the lip. It differs from the ordinary variety in the age of the patient (most of those I have seen have been in young men who were apparently in good health) and in the fact that numerous small abscesses are usually present rather than one single extensive slough. Probably this may be accounted for by the radial direction of the connective-tissue fibres in this part. The ordinary form may occur upon other parts of the face, as on the neck and back, in older people whose health is broken down. The subcutaneous induration is often of immense size, forming a hard, brawny swelling which extends all over the cheek and even down on to the neck. Sometimes this is preceded by a pustule (especially in inoculation cases) and frequently is accompanied by the formation of vesicles, so that in spite of the intense pain there is a superficial resemblance to true anthrax; the bacilli of this disease, however, are never present. In a severe case the constitutional symptoms are typhoid from the commencement, but in many of the milder inoculation ones the patient is but little inconvenienced.

Facial carbuncle is always serious, owing to the risk of meningitis and pyæmia. This arises entirely from the anatomical relations of the part, the free communication between the infraorbital and ophthalmic veins and the venous sinuses of the cranium on the one hand, and between the facial and jugular on the other; it is not the result of any specific quality. Septic embolism of the lungs is found in a very large proportion of fatal cases.

The treatment consists in free incision. In the labial form, for example, the patient should be anæsthetized, and the whole swelling cut across with a sharp-pointed bistoury, introduced into the red margin, with the surface of the blade parallel to the skin. Afterward the sloughs must be scraped out, and the resulting cavities and the abscesses that are opened thoroughly sponged with a 20 per cent. solution of carbolic acid. Usually this stays the progress of the inflammation at once, but the patient often must pass through a long and trying illness before convalescence is complete.

*Anthrax.*—True malignant pustule, due to the inoculation of the bacillus anthracis, is occasionally met with upon the face; but, except that its course is often exceedingly rapid, it does not differ, in any material respect, from the same disease in other parts of the body.

*Cancrum Oris, Noma, or Gangrenous Stomatitis.*—A peculiar form of inflammation, affecting the tissues of the cheek and rapidly running on to gangrene, sometimes occurs in poor, half-starved children, during convalescence from specific fevers, especially measles and scarlatina. Its course and general characteristics are so uniform, that it has been supposed by many to result from the action of a specific germ; but, in spite of the fact that cases of this kind frequently occur together (I have seen three from the same house, inhabited, it is true, by many families), it is very doubtful if there is anything of the kind. It seems much more probable that it is akin to phagedæna, caused by the ordinary organisms of suppuration acting under specially favorable conditions, and that when several cases of it are met with at the same time, their occurrence is the result of the close similarity in the circumstances of life.

Sometimes it begins on the mucous surface, a sloughing ulcer forming near the orifice of Steno's duct (it has been suggested that the administration of mercury favors its occurrence), more often in the substance of the cheek itself. In either case the first external sign is an ill-defined but exceedingly hard patch, usually in the centre; the skin over it is dusky, glazed, and œdematous; the mucous membrane may be raised and livid, or already covered with an ashy-gray slough; there is little or no pain, unless it is handled roughly, and the child scarcely pays any attention to it. Then a bulla arises in the middle, bursts, and leaves a patch of black gangrene, which steadily increases in size, preceded by a narrow, dusky

[illegible], until the whole of the cheek is a coal-black slough, the lips destroyed, the [illegible]e of the nose eaten away, and the jaws beneath exposed without even a cover[illegible]g of periosteum. The destruction on the inner surface of the cheek is even [illegible]der than that on the outer. I have seen it develop on the second side while the [illegible]st was still in progress, until the whole of the face was destroyed, with the ex[illegible]ption of the nose and a small median portion of the two lips.

A similar affection has been described, affecting the external organs of gene[illegible]tion in female children living under the same conditions, but it is much more [illegible]re.

The constitutional disturbance throughout is strangely slight. The child [illegible]ften does not notice it but plays with its toys, eats and sleeps as if it were abso[illegible]tely unconcerned; then it either suddenly collapses or is attacked by septic [illegible]neumonia.

The only treatment of any avail is the actual cautery; the whole of the affected [illegible]art must be deliberately excised. If the skin is not yet involved (such cases are [illegible]arely seen in time) it must be done from the interior, but nearly always there is [illegible]lready a blackened slough. The prognosis, so far as life is concerned, is very [illegible]ad: recovery may, however, take place even when the jaws have been involved, [illegible]eaving the most frightful deformity.

*Erysipelas* of the face is dangerous, from the risk of its spreading to the meninges (though this is not so common as when the scalp is involved) and to the throat, causing erysipelatous laryngitis. The swelling, when it spreads into the eyelids, is often enormous, and may require relief by puncture; on the nose and ears, on the other hand, it is very slight, but intensely painful. Repeated attacks lead, at length, to a very disfiguring degree of solid œdema.

*Lupus.*—The face is the favorite locality for all forms of lupus. The common variety, that which develops in young, fair-complexioned, and perhaps scrofulous subjects, and is characterized by the presence of little semi-translucent tubercles, which break and leave superficial sores, is especially frequent round the alæ of the nose and on the lips and cheeks. Sometimes it causes very serious deformity, destroying the cartilages, leaving the apertures of the nostrils widely open upon the face, and spreading into the gums and palate. It may be known by the age at which it occurs; its chronic, persistent course, the characteristic tubercles, and the thin red cicatrices, always on the point of breaking down. Erythematous or butterfly lupus, in which the amount of new growth is very much less, is more rare; and rarer still is an eczematous variety, often taken for eczema, but differing from it in the presence of a certain though small amount of lupus tissue, and in the fact that it leaves a scar.

*Syphilis.*—All forms of syphilitic eruption are common upon the face. Primary chancres are often met with on the lips, and may occur upon the eyelids and other parts. They are easily recognized by the peculiar character of the induration, and are distinguished from epithelioma by the aspect of their base (which is not covered with epithelial debris), by the rapidity with which the sore develops, and the quickness with which the glands become involved. It rarely happens that a hard chancre has lasted a fortnight before some evidence of these can be found, while an epithelioma, unless it has been irritated, rarely produces any effect under three or four months. Age is not so sure a test. Hunterian chancres may occur at any time of life, and I have seen a typical epithelioma of the lip in a man only thirty years of age. Sex, however, is sometimes of help, as epithelioma is very rare in women.

Secondary eruptions rarely fail. Roseola is the most common, especially on the forehead, under the roots of the hair, and in parts that are irritated by shaving. Alopecia may occur, although it is not so frequent as upon the scalp. The most serious is a form of phagedæna, which, from a superficial resemblance it possesses, has been called syphilitic lupus. It attacks the alæ of the nose, and causes greater destruction in three days than lupus in as many months. Very often it is associated with rupia, and occasionally, especially when it occurs in the later periods of the

disease, with what used to be called *hypertrophic lupus*, an enormous purplish-red enlargement of the lower half of the nose. The only treatment is the acid nitrate of mercury as soon as there is the least indication of its appearance. The cicatrix is firm and dead white, without the least tendency to break down, and utterly unlike, therefore, that which follows tubercular lupus.

Tertiary symptoms are almost as frequent. Papular serpiginous eruptions are common upon the skin around the mouth and nose, and rhagades and painful fissures frequently occur at the angles. The former subside under treatment without a permanent mark; the latter leave dead-white linear radiating cicatrices. In the later stages, when the amount of exudation is greater, these papules are succeeded by scaly dusky-red tubercles, still arranged in the same way. At first these may also be absorbed, although they are liable to leave behind atrophied patches of skin where the papillæ have been destroyed; after a time, however, especially if the health begins to fail, they increase in size, and then they usually break down and suppurate. Later still, and in intractable cases, the amount of exudation may be so great that the tissues perish and sloughing gummata form. Sometimes it is only the skin that is affected; more often there is a sodden mass in the subcutaneous tissue; and occasionally the bones are exposed and huge sequestra similar to those met with upon the forehead slowly exfoliate. Finally, in a few very rare instances, phagedænic gangrene sets in and rapidly proves fatal, from septicæmia or septic pneumonia.

Similar affections occur in the hereditary form, and when no evidence can be obtained from the condition of the teeth or the cornea or the sunken bridge of the nose, it is often enough to mark the dead-white pits that surround the mouth and the linear radiating cicatrices that spread from the angles and the nose. A median cicatrix in the lower lip is of no significance in this respect.

*Leprosy.*—The earlier manifestations of this disease are occasionally met with upon the face in the shape of dusky erythematous patches, slightly scaly, and sometimes symmetrical. As they increase in size the centre becomes anæsthetic and grows paler and paler until it is dead-white. Tubercular masses, leading to great disfigurement, are common in the later period.

*Rhinoscleroma* is a very rare disease, which is only known to occur upon the nose and upper lip. It first appears as a hard nodule, covered over with reddish skin, growing usually from the columna. As time passes it slowly increases in size until it forms a dense, bossy mass, as hard as a fibroma, which blocks up the nostrils, extends along the inferior meatus, involves the palate, and causes an immense projection of the upper lip. By-and-by it begins to ulcerate, but the process is always slow. It may be excised, but, unless it is removed very thoroughly, the wound heals up and the growth begins again. The lymphatic glands never appear to be involved. Histologically it resembles other granulation-tissue growths, composed of ordinary round cells with a few of larger size. Sometimes it appears as if the epidermis were inclined to grow downward, as in epithelioma. Payne and others have described short ovoid bacilli in connection with it, but its proper relationship is still uncertain.

## Tumors of the Face.

*Dermoid* and *sebaceous cysts* are of common occurrence; *meibomian cysts*, which are developed in the eyelids, and *lipoma nasi* (Fig. 324) have been described elsewhere. The various forms of *hairy moles* and of *nævi* which are frequently met with require very careful treatment, for fear of leaving a worse deformity. The former, if small, may be excised; the hair-sheaths in the larger ones are best destroyed by electrolysis, but the method is very tedious. The same may be said of nævi; subcutaneous ones can be dissected out, leaving a fine linear cicatrix, which, if carefully planned, is almost invisible in a few years' time; cutaneous ones, on the other hand, especially those of any extent and in the region of the eyelids, should be very carefully dealt with. The most satisfactory

the application of the constant current, using only the positive pole
itive applied to the skin elsewhere), but it requires a great deal of

*luscum contagiosum* is very common in children and can be recognized by
semi-translucent appearance of the little masses, even when there is no
on upon them. The other variety (*fibrosum*) is rarer, the face often re-
free when the body is almost covered.

*ithelioma.*—Squamous-celled carcinoma may occur in the same region of
as rodent, or upon the nose, but the favorite locality is the lower lip, on
portion, or at the junction of this with the skin. On the upper it is
ingly rare. There is no doubt that it is often caused by the persistent
on of a clay pipe, the soft epidermis of the lip adhering to the porous sur-
the clay, so that when this is removed, it brings away with it the protect-
yer; and it is said to be nearly as common among the women of the lower
in Ireland as among men; but there is no doubt that it does occur also in
who have never smoked.

FIG. 324.—Lipoma Nasi.

It may commence in various ways; either as a crack or fissure which refuses
o heal and grows harder and harder, or as a raised papillomatous surface covered
ith unaltered epithelium. At first its progress is slow; and particularly in old
eople, it may remain concealed beneath a scab for months without apparently
ndergoing any change. By degrees, however, it asssumes the type of an epithe-
iomatous ulcer, with a ragged, irregular, sloughing base, and raised, everted, and
ardened edges. Sometimes, when it is irritated (especially by caustics) it fun-
ates and grows with great rapidity. If it is left, the glands beneath the jaw be-
ome affected, the disease spreads into the surrounding tissues, the ulceration
xtends wider and wider and becomes intensely painful, and the patient, after a
ime, begins to sink very rapidly, worn out by the pain, inability to take food
nd repeated hemorrhages, and half poisoned by the passage of septic debris int
he lungs and the alimentary canal. The glands often attain a very large siz
nd fungate through the skin as well as into the mouth, bleeding profusely at th
lightest touch; but wider secondary deposits are rather the exception.

Exclusion should be performed as soon as possible, the whole affected porti

being removed by a V-shaped incision. As patients usually apply for treatment earlier than in other forms of carcinoma, the results are fairly good; but care must be taken to keep clear of the growth on either side, as there is a distinct tendency for it to spread laterally under the epithelium. The assistant should grasp the lip with his finger and thumb so as to compress the coronary arteries. Hare-lip pins, passed from the cutaneous almost to the mucous surface, are used to bring the wound together, silk being twisted over them in a figure-of-eight, but they must not be left more than forty-eight hours. One or two other sutures may be inserted with advantage and left a day or two longer.

When the glands are involved, the same operation should be performed, and the secondary deposits excised, if there is a chance of removing the whole of the disease. It is true there is scarcely a hope of curing the patient; but, at the risk of what is not a very severe operation, there is a possibility of giving him material relief, and of freeing him from a foul and offensive ulcer, involving more or less the whole of his mouth, poisoning him, and rendering existence almost intolerable.

*Rodent Ulcer.*—This is a variety of epithelioma (beginning in connection with the hair-sheaths) which is rarely met with under fifty years of age and in other parts of the body than the forehead, face, and scalp. It is exceedingly slow in its progress, and does not involve the lymphatic glands; but if left to itself or incompletely removed, it tends slowly to infiltrate and eat into all the structures near, until, if it is growing at the corner of the eye (its favorite seat), it may destroy the eyeball and expose the brain. It usually begins as a reddish-brown elevation of the skin, like a wart. By degrees this becomes scaly, and then, after the surface has come away a few times, a small ulcer forms; the edges irregular, sinuous, a little raised and already hardened; the base depressed, pale, devoid of granulations, and secreting a thin serous fluid. The longer it lasts the wider and deeper it spreads; but, usually, it is several years before it attains any size. Throughout, unless it is irritated and inflamed, it retains the same indolent character, but I have known it spread much more rapidly after ineffectual attempts at removal by means of caustics and poultices.

The only treatment is complete removal, the earlier the better.

Other forms of malignant growth (independently of those spreading from the bones and subjacent structures) are rare. I have met with a pigmented form of epithelioma upon the cheek, and with one or two instances in which sarcomatous growths apparently originated in the subcutaneous tissue; but the diagnosis and treatment present no special feature of interest.

**The diagnosis** between lupoid, syphilitic, rodent, and epitheliomatous ulcers upon the face, occasionally presents a little difficulty.

*Age.*—Lupus occurs chiefly in young adults; syphilis in adult life; epithelioma and rodent not until much later.

*Course.*—Lupus is very chronic; probably it has already lasted months or even years. Syphilis is more acute, often it is only a question of days; although I have known patches of a syphilitic tubercular eruption persist for months without much change. Epithelioma is fairly rapid, especially if it is irritated, making more progress in a month than rodent in a year.

*Tendency to Heal.*—This is nearly always present in lupus, and the cicatrix is red, and so thin that it is always breaking down again. If it occurs in syphilis, the scar-tissue is dense and white. It is not present in rodent or epithelioma, except as a result of operation.

*Origin.*—Groups of semi-translucent lupus tubercles round the margin are distinctive; those of syphilis are never really like them, except in shape. A single hard nodule may precede the others.

*Edges.*—The outline of lupus is usually irregular and the margins soft. Syphilitic eruptions have a tendency to assume a crescentic form. Rodent is generally circular, with hard, rounded, rolled-over margins; while in epithelioma the induration always extends a considerable distance.

*Base.*—In lupus the surface is concealed beneath scabs or covered with pale,

bby granulations. A syphilitic sore, so long as it is spreading, is foul and oughing; rodent is smooth and glossy on the surface; while the floor of an epi-eliomatous sore is hard, nodular, covered with epithelial debris, and secretes a ul, purulent discharge.

## DISEASES OF THE NOSE.

### Malformations and Deformities.

Congenital malformations are rare; deformities on the other hand, resulting m injury, lupus, or syphilis, are very common.

Deviations of the septum should be straightened at once by means of forceps; t the tendency to return, even in the case of accidents, is so great that either e process has to be repeated again and again, or a truss or mask, devised for ch special case, must be worn at night.

Extensive destruction of the soft parts can sometimes be remedied by means a plastic operation; but, in cases in which it is due to disease, this should ver be attempted until the stump is perfectly sound. The two best known thods are the Indian, and that first carried out by Tagliacozza (the Italian).

In the former a flap of suitable shape is marked out upon the forehead, hav-g its pedicle immediately over the root of the nose, or slightly to one side, so at it can be twisted down more easily. This is carefully dissected up (Langen-ck recommends that the periosteum should be brought away with it), adjusted in bed prepared for it by cutting away the old scar tissue around the margins of e orifice, and secured with sutures, hollow plugs being inserted into the nostril, that it may retain its shape. To avoid the sinking inward of the tip, Langen-ck reflected some of the bony margin of the nostril, fashioning a flap from each le, so that they should meet like the rafters of a roof in the middle; but when e nose has been destroyed by inflammation this proceeding is rarely practicable.

In the Indian method the skin is taken from the arm over the biceps. In the iginal plan the flap was raised by an incision down each side and left to granu-te; then the upper end was separated; and after the skin, detached now on three les, had begun to shrink, it was carefully fixed by sutures in the freshly cut mar-ns of the defect. The arm is fixed with plaster bandages in a suitable position, d it must be retained like this without the slightest traction for at least eight ys. The treatment has since been shortened by detaching the flap at an earlier te, but naturally with some risk.

Of these two methods there is no doubt the former is the better where it is acticable, in spite of the scar it leaves. In the latter the transplanted flap sinks to a shapeless mass. Neither, however, is really satisfactory, and it is probable at in most cases the deformity would be better concealed by an artificial nose, ade from vulcanite or enameled silver, and fastened on to a spectacle frame.

In cases in which one ala only is defective, Langenbeck's plan of reflecting a p from the other on the opposite side (leaving it attached by a bridge upon the rsum) tends to diminish, or at least equalize the deformity. There is, however, me difficulty in separating the skin from the cartilage without cutting or bruising owing to the very close connection that exists between the two.

### Epistaxis.

Hemorrhage from the nose may be very serious, the blood pouring down the sterior nares as well as the anterior, and being swallowed, so that the patient is t aware of the amount that is lost. In most instances it is merely a symptom some other trouble, sometimes a very grave one; but, for convenience of classi-ation, the causes may be divided into general and local.

(*a*) *General.*—Some of them are congenital—hæmophilia, for example—and curious tendency toward nose-bleeding, which is not uncommon in certain nilies, sometimes in both sexes, more often in the males alone, and only persists

during certain years of life. Morbid conditions of the blood, as in scurvy, leukæmia, purpura, acute specific fevers, etc.; and general affections of the circulation, such as are met with in connection with Bright's disease, cirrhosis of the liver, plethora and gout are more common. In some instances epistaxis is said to be vicarious.

(*b*) *Local.*—All forms of injury, inflammation (whether specific or not), and new growths, may be attended by epistaxis. It rarely happens, however (except in the case of naso-pharyngeal polypi, and occasionally as a result of injury), that the loss from these causes is of the same serious and persistent character as from the former. It may be smart for the time, but as there is no constitutional disorder, no serious affection of the blood or blood-vessels, it can usually be checked without difficulty.

**Treatment.**—Raising the corresponding arm above the head; compressing that side of the nose with the finger; cold-sponging of the face; applying cold to the nape of the neck, and other simple remedies should be tried first. If they do not succeed, the patient should lie down and an ice-bag be applied over the nose, but watch must be kept that the blood does not trickle down into the pharynx. All muscular effort, and especially blowing the nose, must be forbidden. Washing out the nose with ice-cold water, or with water tinged with perchloride of iron, is more effectual. The internal administration of such drugs as acetate of lead, gallic acid, and ergot, is of little use, though more may be said in favor of opium. Finally if the hemorrhage persists or returns again and again, the nostrils must be plugged.

There are two ways in which this may be accomplished. The best is with a thin dilatable rubber tube, which may with advantage have two bulbs upon it about an inch apart, for the better closing of the apertures. This must be passed by means of a long probe along the floor of the inferior meatus, until the further of the two bulbs lies in the posterior nares; then distended to its utmost with air or water, and the contents prevented from escaping by clamping or tying the projecting end. It fits accurately into all the recesses, exerting an equable degree of pressure, and fills the cavity so closely that very little blood collects. At the end of twenty-four hours the contents may be allowed to escape, and the bag quietly withdrawn.

Where this is not at hand and cannot be improvised, Bellocq's sound, or, failing this, a gum-elastic catheter, must be used. The sound is passed down the nostril; the end protruded, and caught in the mouth; it is then threaded with stout silk and withdrawn, leaving a double ligature passing along the inferior meatus, behind the soft palate and out through the mouth. Two plugs are then prepared, of compressed sponge or cotton-wool, about the size of the last phalanx of the thumb. One of these is tied tightly round the middle and fastened to the threads hanging from the mouth. The ends should not be cut off, but left, so that when the plug is carried on the tip of the finger to its proper site, the posterior nares, they may hang down in the pharynx. As soon as this is adjusted the other ends, projecting from the nostril in front, are drawn tight and knotted securely together over the other plug, which is placed

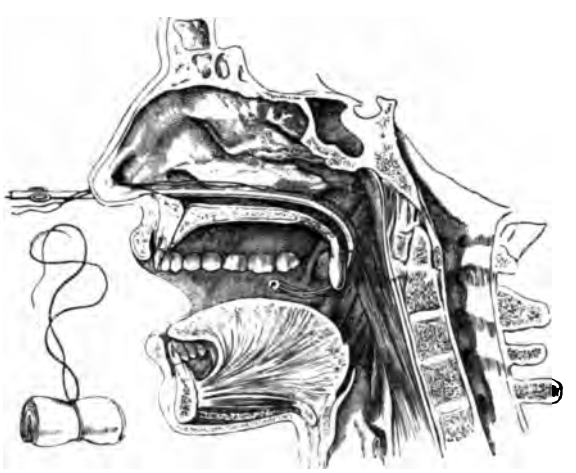


FIG. 325.—Bellocq's Sound.

between them in the anterior opening. At the end of twenty-four hours the string that hangs down the pharynx should be fished up, the knot that secures the anterior plug divided, and the two gently drawn away. If they are left longer they are very likely to cause ulceration; and, as the whole cavity of the nose is filled with blood, which soon decomposes, this may lead to very severe inflammation and necrosis, or even worse.

### Inflammation of the Mucous Lining.

*Acute catarrhal inflammation* is easily caused by exposure to cold or by irritating dust or vapors. The mucous membrane becomes swollen, there is a profuse watery discharge with sneezing (coryza), the respiration through the nose is obstructed, smell and taste are lost, and, if the lining of the frontal sinuses is affected, there is usually frontal headache with a certain amount of fever. In most people this subsides as soon as the irritant is removed, or yields at once to ordinary remedies, such as Dover's powder or a Turkish bath; but, occasionally, either because the tissues are peculiarly delicate and unable to regain their strength at once, or because of the persistence of some irritant, the inflammation continues, spreads over the adjacent mucous surface, and becomes chronic.

*Chronic inflammation* is either the result of frequent repetition, the congestion and exudation of one attack not having time to subside before they are made worse by another; or of some constitutional disorder such as tubercle, syphilis, or gout. In many cases it is associated with outgrowths from the mucous membrane (polypi and adenoid growths) caused by the persistent irritation.

Numerous varieties have been described, some well characterized. One, for example, is frequent in syphilis, especially the hereditary form, causing what is known as *snuffles*. Another, the *hypertrophic* variety, is almost as common in scrofulous subjects about puberty. The mucous membrane (chiefly that covering the inferior turbinate bone) is enormously thickened; the surface is red and granular, secreting a thick muco-purulent discharge; the nasal passages are blocked, the hypertrophied mucous membrane fills the posterior nares, and projects so far into the anterior that, in spite of the color and rough appearance of the surface, it is often mistaken for a polypus; the wall of the pharynx becomes affected, the Eustachian tubes are closed, and the tone of the voice completely altered. In a third (*atrophic catarrh*), which may possibly be a further development of this, the change is exactly the opposite; the mucous membrane becomes atrophied, the glands disappear, and the nasal cavities are enlarged. With this is often associated a form of ozæna, due apparently to the decomposition of discharge retained in outlying dilatations or prevented from escaping by the crusts and scabs that form. In many instances, however, particularly when there is no specific irritant, no definite classification is possible; the mucous membrane simply becomes rough and granular, the layers beneath hard and fibrous, the glands enlarge, their secretion alters, the veins, and probably the lymphatics, become varicose, and the smooth, soft, natural surface is completely lost.

**Treatment.**—Syphilitic coryza quickly disappears under mercury; and, though the prospect is less hopeful, a very great deal of improvement can be effected in scrofulous cases by iron, cod-liver oil, and especially residence at the seaside. Local treatment, however, is usually required as well. Temporary relief, especially from the attacks of sneezing, which are often very painful, can be obtained by brushing the mucous membrane over with a 5 per cent. solution of cocaine. The spray or the nasal douche is more effectual for checking secretion and diminishing congestion. Tannic acid, sulphate or chloride of zinc, carbolic acid, tincture of eucalyptus, and many other astringents and antiseptics are recommended; the chief thing is the thoroughness of their application. If the spray is used, it must be directed up the posterior nares by means of a properly curved nozzle, as well as up the anterior; if the douche, the stream must be of full volume and allowed to flow back through both nostrils. Afterward an astringent

powder (tannic acid, for example, with subnitrate of bismuth, or alum and oxide of zinc) should be applied, but care must be taken not to make the inflammation worse by constant irritation.

In cases in which the hypertrophy is extreme, it may be necessary to reduce the swelling by caustics or by removing some of the redundant tissue. Nitric acid has been applied with benefit, and so has the actual cautery; and portions of the turbinate bones may easily be removed with forceps (this is often done in the case of polypi), but the most effectual method is the galvano-cautery, the loop of wire being adjusted over the projecting part and gradually tightened up; the margin of the septum and of the ala must be protected with an ivory speculum.

### Inflammation of the Bones of the Nose,

leading to caries and necrosis, is usually the result of syphilis, hereditary or acquired; but it may be due to tubercle or glanders, to injury, the presence of foreign bodies, septic decomposition, mercury, and occasionally the fumes of bichromate of potash. The septum may be attacked, so that the bridge of the nose sinks in (although, in an adult, a great deal may be lost without any apparent alteration in shape), or the turbinate bones, or the roof, and in the latter case there is always the risk of meningitis. The symptoms are those of inflammation of the mucous membrane, but the discharge is always profuse and fœtid, the breath exceedingly foul, and nothing, so long as any dead bone is there, gives more than temporary relief. In many cases the diagnosis is clear at the first

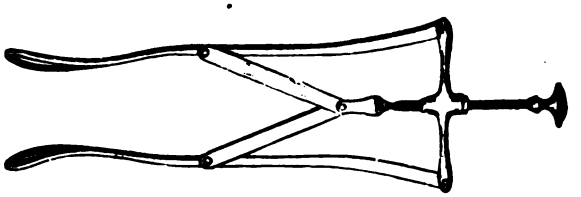


Fig. 326.—Nasal Speculum.

glance; either there is a perforation of the hard palate, or a probe introduced into the nasal cavity strikes the sequestrum at once; but sometimes, especially when it lies toward the upper and back part, detection is a matter of very great difficulty.

**Treatment.**—The dead bone must be removed as soon as it is loose, careful attention being paid at the same time to any constitutional taint that is present. In most cases it can be extracted, under an anæsthetic, through the anterior nares; sometimes it is easier to push it back into the pharynx (the two forefingers can usually be made to meet in the inferior meatus of the nose, the one introduced from the front, the other from behind, when the patient is anæsthetized), but the operator must be prepared for free, though not usually serious, hemorrhage. Where, owing to the size of the fragment, this cannot be done, *Rouge's operation* may be performed, *i. e.*, an incision made through the mucous membrane, where it is reflected from the under surface of the upper lip on to the gum, the cartilaginous septum detached from the anterior nasal spine, and, if necessary, from the maxillary crest; the alæ detached at the margins, and the upper lip with the nose lifted up and reflected on to the forehead. The nasal cavities are thoroughly opened up to view by this, the whole interior can be examined, and then the nose and lip replaced without a suture being required, or a mark left.

If the dead bone, without being loose, is fairly accessible, as frequently happens in hereditary syphilis, it may be partially dissolved away by a sulphurous acid spray (which also helps to check the fœtor), and occasionally can be chipped off in little pieces with a fine chisel, but care must be taken that the instrument does not slip and penetrate the roof.

### Ozæna.

By this is understood a persistent, offensive discharge from the nose, caused ther by necrosis (syphilitic, tubercular, or traumatic), or by the atrophic form ' catarrhal inflammation. The smell, which is often not perceptible to the patient liffering in this respect from ozæna of the antrum), is infinitely more offensive an that of ordinary putrefaction. Possibly, in necrosis cases this is due to the esence of dead bone (which, it is well known, possesses this property); in hers, however, it must arise from some special kind of fermentation, for which ere is every facility.

Opinions differ very greatly as to the relative proportion of cases in which ad bone is present. According to some it is never wanting, although there may great difficulty in finding it; sometimes it has not been discovered until Rouge's eration has been performed. Probably it is present in the majority, especially there is very often evidence of syphilis, and certainly its absence should never assumed until after the most thorough exploration.

**Treatment.**—Constitutional treatment is always needed; even when there no necrosis, there is very frequently ulceration depending upon some constitu- nal taint, such as syphilis or tubercle. Locally, the first thing is to reduce the tor as far as possible by means of the nasal douche, using Condy's fluid and -y dilute carbolic acid at first, and, later, when the patient is more accustomed it, chloride of zinc (one-eighth of a grain to the ounce), and corrosive sub- iate (1 in 10,000). The chief difficulty is to make the lotion penetrate into : recesses, and this is hardly possible unless the bore of the tube is as large as : nostril will admit. In many cases, the spray and volatile antiseptics, such as line vapor, sulphurous acid and eucalyptus, are more effectual. As soon as this to some extent overcome, the interior of the nose must be thoroughly examined, th by sight and touch, from in front and behind. If any dead bone can be ind, it should be removed or chipped away, so as to reduce the size of the offen- e surface; lupoid ulceration must be thoroughly scraped out, the bleeding being ipped with the actual cautery, and syphilitic sores touched with the acid nitrate mercury.

If the disease is too extensive to be dealt with through the interior nares, or no cause can be found, and the ozæna still persists, in spite of all that can be ne, the interior must be further exposed by operation. Not only is the patient's esence almost intolerable to others, but his own life is seriously endangered by : constant inhalation of the poisonous odors. One or both alæ may be re- cted without leaving any conspicuous mark if the line of incision is carried along : junction of the nose with the face, but in most cases Rouge's operation is eferable, as being more thorough and leaving no deformity.

### Tumors of the Nasal Passages.

The majority of tumors that grow in the interior of the nose tend to assume : polypoid shape. Some (adenomyxomata, the so-called mucous or gelatinous lypi) spring from the submucous tissue covering the turbinate bones, especially : middle, but occasionally the superior. Like the polypi that occur on other icous membranes, they are essentially local hypertrophies, caused by constant itation. Others, which are very much more rare, are formed of fibrous or fibro- :comatous tissue in varying proportions, and grow from the roof and occasion- y the septum. These belong to the same order as the naso-pharyngeal polypi iich are attached to the roof and other parts of the pharynx, and spread from em into the nose. In addition, a few cases of papilloma and columnar epithe- ima are recorded, but they do not require special mention.

*Mucous polypi* are composed chiefly of mucous or myxomatous tissue, covered er with columnar ciliated epithelium; but portions of glands (sometimes newly rmed), cysts, and even widely dilated vessels, giving them an almost cavernous

structure, are met with as well. They form soft, gelatinous, semi-translucent masses, pale pink or yellow in color, projecting from the surface of the mucous membrane, and sometimes reaching far into the anterior and posterior nares. At first they are small and sessile, and in any advanced case numbers in this stage can be seen between the larger ones. Those that project toward the front can usually be seen at once (or if the patient expires forcibly), forming smooth, pedunculated masses very soft to the touch, and moving up and down with each breath. The deeper ones may require a speculum, and those that grow into the posterior nares can only be detected by introducing the finger round the margin of the soft palate. Occasionally, when one has been exposed to the air for any time, the surface becomes dry and rough, and then it may possibly be mistaken for an overgrowth of the mucous membrane over the inferior turbinate bone; otherwise it is difficult to see how such an error can arise.

**Symptoms.**—Chronic catarrh is always present. The breathing is obstructed (especially in wet weather, when the polypus swells up): the mouth is held open; the voice is altered and becomes nasal; the sense of smell, and often that of hearing, is lost; and nearly always there is constant frontal headache. In severe cases the shape of the nose may become altered by the internal pressure; the lachrymal duct obstructed; the septum displaced to one side; and the Eustachian tube blocked up. As a rule, there is no bleeding and no offensive discharge, both of which symptoms are common in the case of malignant growths.

FIG. 327.—Method of Grasping Mucous Polypi.

**Treatment.**—There are various ways of removing polypi. The simplest is to grasp the neck as high up as possible with a pair of slightly curved forceps, having long serrated blades, and twist it round and round until it comes away (Fig. 327). Mitchell Banks recommends that in bad cases the patient should be anæsthetized upon a sofa, and, when fully insensible, brought to the edge and placed so that the head hangs over. The surgeon then, kneeling on the floor, pulls out whole masses of the middle turbinate bone with the polypi upon them. If there is a very distinct pedicle, the ordinary wire écraseur may be employed, or the galvano-cautery, cocaine being used to allay the pain and prevent sneezing. Polypi that lie far back, in or near the posterior nares, can only be snared if the forefinger of the other hand is carried round the back of the soft palate to guide the loop. The bleeding is free, but stops at once upon the application of ice-cold water.

The chief difficulty is to make the removal thorough; and the operator should not be satisfied until the route between the two nares is completely freed. Even then many small growths must be left behind, and these, released from the pressure of the larger ones, and, stimulated by the inflammation that follows the operation, are almost sure to spring up rapidly. To prevent this, tannic acid or sulphate of zinc may be used as snuff, or the cavity may be washed out with boracic acid and alcohol, or with other astringents; but constant care is needed. In the worst cases it may be necessary to perform Rouge's operation.

*Naso-pharyngeal Polypi.*—These include all the varieties of fibroma, sarcoma, and fibro-sarcoma, which grow from the roof of the nose, the pharynx, or the pterygo-palatine region. They are met with chiefly at puberty, and in boys, form-

ing roundish, lobulated masses, covered over with a vascular mucous membrane. Some grow slowly and are firm and dense; others (which in all probability are round or spindle-celled sarcomata) are much softer and increase in size very rapidly. They are all exceedingly vascular (the walls of the vessels being very thin), so that they bleed with the least provocation and very profusely; and they spread in all directions, forming secondary attachments wherever they exert any pressure upon the mucous surface. The favorite locality is the basilar process, spreading forward into the nose and down into the pharynx; but they grow sometimes from behind the superior maxilla (simulating a tumor of the antrum, except that the hard palate and the alveolar border are not depressed); from the ethmoid and sphenoid bones; and even from the septum. Occasionally enchondromata are met with.

The symptoms depend upon the direction the polypus takes. A fœtid, blood-stained discharge is nearly always present, as the surface of the growth breaks down and ulcerates; sometimes the epistaxis is so severe as to threaten life; the nostrils may be obstructed; the Eustachian tubes closed; deglutition may be impeded, and the most repulsive deformities (exophthalmos and frog-face) caused by the displacement of the features. Sometimes there is constant headache with a tendency to coma and convulsions, suggesting that the meninges are implicated. It is said that naso-pharyngeal growths sometimes atrophy, and they have been known to slough away of themselves, but, as a rule, progress is steadily from bad to worse, the profuse hemorrhage in particular reducing the patient's strength.

The only treatment is free removal with thorough destruction or ablation of the surface from which it springs. Otherwise it is certain to return.

Small growths might probably be sometimes caught and twisted off, with properly contrived forceps introduced through the nose, while the finger directs them from behind the soft palate. If a loop of wire can be adjusted round the neck, the bulk of the growth can be removed with the galvano-cautery, or, if this is not at hand, with an ordinary wire écraseur; but in either case the base must, in addition, be thoroughly seared. Hemorrhage is sure to be profuse, and, particularly if the growth is a large one, springing from the base of the skull, there is very considerable risk of causing meningitis.

Electrolysis has succeeded and deserves a further trial. Both needles must be inserted and a current used as strong as the patient can bear, with the view of causing sloughing.

In most cases, however, a preliminary operation is required, in order to get sufficient space; the origin of the growth is not accessible without. Where this should be done depends upon what can be found out with regard to the position of the pedicle and the direction the growth has taken.

(*a*) If the polypus is situated low down it may be enough to divide the soft palate in the middle line (the flaps have been known to unite together again of themselves without a subsequent operation); or, if this is not sufficient, to reflect the periosteum and mucous membrane from the under surface of the hard palate and remove some of the bone as well. This, however, is a serious addition.

(*b*) When it grows forward toward the nose, Rouge's operation with free division of the septum might give sufficient room; and in a case of frog-face a median longitudinal incision between the separated nasal bones has been practiced. Langenbeck reflected upward the nasal bone and the nasal process of the superior maxilla, using as a hinge the skin, periosteum, and mucous membrane, connecting them with the frontal. Two incisions were made through the bone; one vertical through the nasal, the other from the anterior nares to the margin of the orbit.

(*c*) Retromaxillary growths can only be reached by excision or reflection of part of the upper jaw. Excision of the whole seems unnecessary; the orbital plate should be left, a saw-cut being made through the bone parallel to it and well below it.

Temporary resection has been practiced in various ways, of which the best

known is that of Langenbeck. It consists in reflecting inward, toward the middle line, a flap consisting of part of the malar bone and the whole of the superior maxilla, bounded by the pterygo-maxillary fissure behind, the floor of the orbit above and the roof of the palate below, with the soft parts covering it. The hinge is the suture between the superior maxilla and frontal.

Incisions down to the bone are made: (1) from the nasal process along the inferior margin of the orbit on to the middle of the malar bone, or even the zygoma; and (2) from the ala of the nose parallel to the former, as far back, and then turning upward to join it. The origin of the masseter must be carefully detached as far as exposed. An elevator is then pushed through the posterior end of the incision down to the zygomatic surface of the superior maxilla, and carried onward until it enters the pterygo-maxillary fissure, and can be felt under

FIG. 328.—Plan of Incision for removal of portion of upper jaw. (*After Esmarch.*)

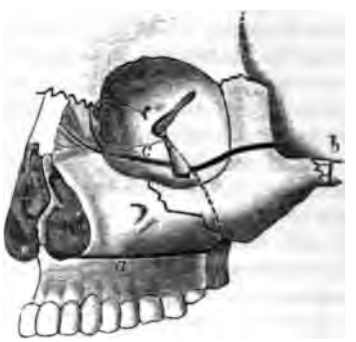


FIG. 329.—Plan of Bone Section, Removal of upper jaw and malar bone. (*After Esmarch.*)

the mucous membrane with the finger passed into the mouth. In a case of polypus there does not appear to be any difficulty in this, as the pressure of the growth widens out the fissure. The incisions are then made through the bone from behind forward, in the line of the superficial ones, the upper passing through the malar bone, the malar process, and facial surface of the superior maxilla to the inner angle of the orbit, the lower parallel to this above the alveolar border. A straight, narrow saw must be used for this, the depth of the cut being guided by a finger in the mouth. As soon as this is done the included portion of the bone, with the soft parts covering it, is freed behind, above, and below, and can be levered out from the pterygo-maxillary fissure, turning on its hinge in front. This exposes the orbit, the temporal fossa, the nasal cavities, and the pharynx, into all of which the retromaxillary growth may have advanced; after the tumor has been removed the bone can be replaced and secured in position with sutures.

# CHAPTER XI.

## *INJURIES AND DISEASES OF THE MOUTH AND FAUCES.*

## MALFORMATIONS.

### Cleft Palate.

Cleft palate is caused by the imperfect development of the palate process growing inward from the superior maxillary. It may involve the soft palate only, or even the uvula by itself (bifid uvula); or the soft and part of the hard; or the whole length of both, and then it is always associated with hare-lip on one or both sides. When the intermaxillary portion is separate it usually carries three incisor teeth, sometimes only two; and very often in these cases there is a pre-canine incisor developed, more or less perfectly, on the posterior margin of the cleft. Whether this is due to the (possible) development of each intermaxillary bone from two centres, the cleft running between them; or to a reversion under conditions of abnormal development to the original number of six incisors; or whether it simply indicates a general disarrangement of the dentinal papillæ, is uncertain. Nothing is known as to the cause of the arrest, which must take place at a very early period of fœtal life. It is sometimes hereditary, and it is said that there is a distinct tendency to it, when one of the lateral incisor teeth is wanting in the parent. It is, however, more to the point that the arrest is only complete in a very small number of cases; the palate processes are seldom altogether deficient; very often one side (usually the right) is fused with the vomer; and they continue to grow for the first few years of life, so that not unfrequently the cleft actually becomes narrower, especially in front.

Syphilis often leaves median perforations, both in the hereditary and the acquired form; but the soft palate is never symmetrically defective, and there is always a large amount of scar tissue.

Infants with this defect are unable to suck in the ordinary way; sometimes they can manage it if there is a flap attached to the teat, closing the aperture into the nostril, or if the teat is very large and thin with a hole on its under surface; in other cases they must be fed with a long-necked bottle, so that the fluid is poured quite to the back of the throat. After a time the difficulty diminishes, the tongue becoming hypertrophied and somewhat altered in shape. The growth of the palate and the ultimate success of the operation may both be seriously endangered by imperfect feeding during the first few months of life.

The time for the operation depends upon the extent of the deformity and the condition of the child; five or six years is the usual age; by that time the parts are fairly well grown and the child should be able to stand an operation. If, however, the defect is unusually great, it is better to wait a year or two than run the risk of an unsuccessful attempt. The soft palate is generally operated upon first, but Smith recommends that, unless there is some exceptional difficulty, the whole should be completed at once.

The patient is placed in the dorsal position with the shoulders raised and the head rather thrown back. An anæsthetic is not absolutely necessary, but if care is taken to watch the breathing and prevent blood passing down into the larynx, chloroform may be given through the nose by means of Junker's apparatus. Smith's gag, opening both sides of the mouth, and combining with it a tongue-depressor, is the most satisfactory, but Mason's or Coleman's should be at hand. The rings of the gag are held behind the neck by a responsible assistant, whose sole duty it is to attend to the position of the head and the breathing, especially as the continued depression of the base of the tongue may cause a little difficulty.

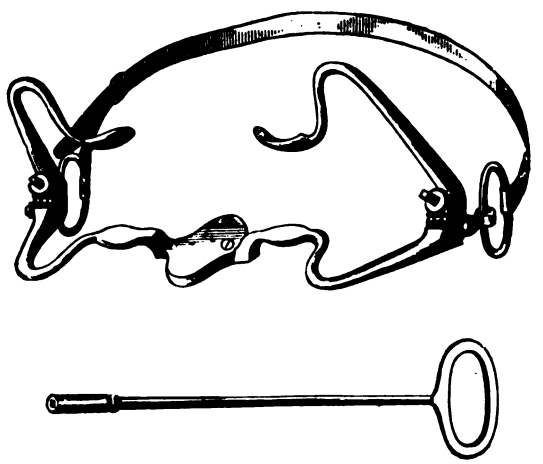


FIG. 330.—Smith's Gag with Tongue Depressor.

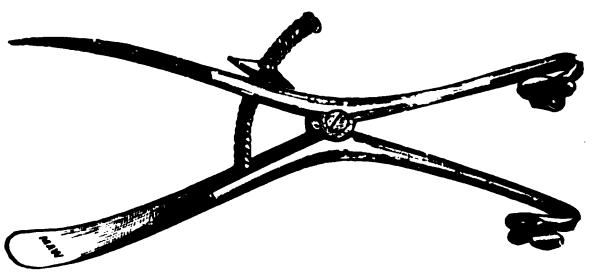
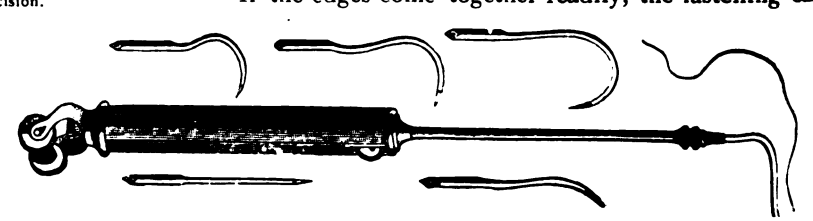


FIG. 331.—Coleman's Gag.

(*a*) When the soft palate only is involved. As soon as the gag is in position and the patient anæsthetized, the tip of the uvula on one side is caught with a long pair of mouse-toothed forceps, and a flap cut from the margin of the cleft from below upward. The other side is then seized and pared in the opposite direction. The whole of the mucous edge must be removed and care taken to obtain as wide a raw surface as possible, especially at the angle, where union fails most frequently. Fine silver wire or horse-hair is used for the sutures. If the edges fall fairly well together, the former can easily be passed with one of Smith's tubular needles (Fig. 333), taking both sides in a single sweep. If horse-hair is preferred, a short curved needle may be threaded on each end and passed separately through each half of the flap with a needle-holder; or Avery's method may be employed. In this a loop of silk is passed through one side of the cleft with a needle on a handle, caught with a pair of forceps, and drawn out sufficiently far to project from the mouth. Then a single horse-hair is passed opposite to this, through the other side and threaded through the loop. When this is pulled back again it draws the hair through the second side with it. In the case of the uvula a rectangular needle on a handle can generally be used.

FIG. 332.—Cleft of the Soft Palate, dotted lines showing line of incision.

The lowest suture is passed first. By drawing on this the palate is made tense and the passage of the next is easier; the same process can be continued the whole way, the assistant keeping the ends of the sutures separate. If the edges come together readily, the fastening can be



completed at once; if not, the loops must be just drawn together, so that the operator may see where the tension is greatest, and lateral incisions made to relieve it. The levator palati is the chief cause of the difficulty, but free division of the mucous membrane, especially on the nasal surface of the palate, is almost equally essential.

A puncture is made with a sharp-pointed knife (like a tenotomy knife on a long handle) inside the hamular process, midway between the teeth and the cleft, and on a level with the highest suture. A similar instrument, but with a blunt, rounded point, is then passed through this, and an incision made downward and backward through the tissues of the soft palate, as far as may be necessary. The wounds gape immensely at once, the edges come together readily, and the sutures can be tightened up, a twister or a pair of torsion forceps being used for the wire ones. If the tension is very great, the incision may be half the length of the soft palate, but a shorter one is usually sufficient. One of the palatine branches is always divided, but the hemorrhage is seldom serious.

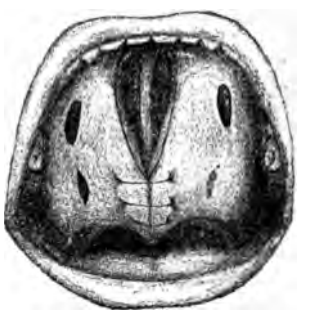


FIG. 334.—Soft Palate sutured, with lateral incisions for the relief of tension. In the hard palate, site of puncture, midway between teeth and edge of cleft: and line of incision along the latter.

(*b*) When the hard palate is involved as well: the gap in this case is closed by detaching the mucous membrane (and as much of the periosteum as will come with it) from the under surface and inner side of the palate process, and displacing it toward the middle line. In front and behind the flaps are left attached, so that they hang down like two horizontal curtains.

To separate these flaps, a puncture is made down to the bone in the centre of one side of the hard palate, midway between the teeth and the cleft, and midway between the anterior angle of the latter and the posterior margin of the bone. A curved raspatory is thrust in at this spot and worked toward the middle line until it projects into the cleft, detaching the periosteum before it. It is then withdrawn, a more curved one inserted into the puncture through which it protruded, and all the structures covering the hard palate, out as far as the puncture, forward to the teeth and backward to the junction of the hard and soft palate, completely detached. The same thing is done on the opposite side.

The next step is to divide the connection between the upper surface of the soft palate and the floor of the nose, where the fascia is especially firm. Scissors curved on the flat are used. The palate is drawn forward, one blade passed between the flap and the bone, the other above the upper surface of the palate, and the mucous membrane cut through as far as the wall of the pharynx. The flaps now meet together easily, particularly if the palate is a high one. Wire sutures are passed and drawn together, taking care that the edges are everted; the original puncture in the centre of the hard palate is prolonged sufficiently to remove all tension, and then the sutures are twisted up.

Hemorrhage may be free for a moment or two, but it generally stops of itself. In the case of the soft palate, it is very rarely of any consequence, and sponging is hardly required; the more this can be dispensed with the better, as it delays the operation and tends to make the patient sick. If the lateral incisions bleed, the head can be turned to one side and the mouth syringed out with ice-cold water. Detaching the periosteum is occasionally attended with a good deal of bleeding, but a sponge on a holder, pressing the flap against the bone, stops it at once. Secondary hemorrhage from the palatine arteries, which may be very serious, must be stopped by plugging the descending palatine canal.

Respiration requires careful watching, not only on account of the anæsthesia, the position of the head, and the pressure upon the base of the tongue, but because of the danger of blood trickling down the larynx. Later, severe broncho-pneumonia, which is almost fatal to union, may arise from this.

**After-Treatment.**—The child must be kept as quiet as possible after the operation, and only a few drops of ice-cold water allowed for some hours, for fear of causing sickness. All food must be fluid, or semi-fluid, and taken very slowly. If possible, the child should be kept in bed, at any rate for the first few days; and if it is fretful and inclined to cry, small doses of chloral may be given. The mouth should not be looked at for a fortnight; the sutures, if there is no tension upon them, may be left longer still.

Union fails most frequently at the junction of the soft with the hard palate; sometimes the whole breaks down, but it rarely happens that the flaps slough. If union is not perfect, a considerable time, six months at least, should be allowed to pass before a second operation is tried. Occasionally a third or even a fourth is necessary; but in many of these a more satisfactory result can be obtained by wearing an obturator. Afterward no pains should be spared to improve the articulation and educate the muscles. In the slighter cases, which admit of early operation, phonation may be almost perfect; but when the defect is very considerable, so that the palate, even though it is restored, forms merely a tense septum extending partially across, the accent is never lost. The fibres of the superior constrictor, extending from one hamular process to the other, become hypertrophied, so as to close the communication more completely, but the flap never can vibrate properly, and not unfrequently, after some time, the cicatrix contracts and makes matters worse than they were immediately after the operation.

## INJURIES OF THE MOUTH AND FAUCES.

Lacerated wounds of the tongue are of frequent occurrence in epileptic fits and from falls upon the chin; and the hemorrhage is sometimes serious. The wounds always heal by granulation, although the attempt may be made to draw the surfaces together by means of deeply placed catgut sutures.

The soft palate, the tongue, or the tonsils may be very seriously injured by foreign bodies, such as the stem of a tobacco-pipe or a piece of stick being violently driven into the mouth. The internal carotid, or the ascending pharyngeal artery, has been torn open in this way with fatal consequences. In some cases the extraction of the foreign body has been followed by a torrent of blood; in others suppuration has taken place, usually because of some fragment left behind, and the artery has not given way for some days. In the latter case there is nearly always a warning first. If the bleeding is slight an attempt may be made to control it from inside the mouth by means of ice, or, if this fails, by turpentine or solid perchloride of iron held against the spot; but, if it is severe or if it returns, ligature of the common carotid should be performed at once. It has been proposed in these cases to tie the external as well, so as to prevent, as far as possible, the blood finding its way round through that part of the collateral circulation.

Fish-bones, pins, and other pointed structures are occasionally driven into the mucous membrane in deglutition; and at times they cause a considerable amount of inflammation. Very often they can be felt with the finger better than they can be seen.

## DISEASES OF THE MOUTH AND FAUCES.

### Inflammatory Affections.

Acute inflammation of the mucous membrane of the mouth is common in infancy and childhood, and is occasionally met with later in life, about the time of eruption of the molar teeth. It is often associated with disordered digestion, the two being dependent to a great extent upon the same cause; and it is especially frequent among the children of the poor and those who live under bad

hygienic conditions. Various forms of it are described, but they seldom occur independently of each other.

*Catarrhal stomatitis* is the mildest; the mucous membrane swells up and becomes a brighter red; the epithelium has a sodden white appearance, and after a time is detached in patches; the tongue is raw and red, indented by the teeth; the gums are soft and spongy; and here and there the surface is marked by shallow erosions. In what is known as *follicular stomatitis* the orifice of each mucous gland is marked by a swollen, bright red areola.

*Aphthous stomatitis* is difficult to distinguish from the last. It makes its first appearance as a group of yellowish vesicles, which break and leave superficial ulcers, about the size of a pin's head, covered with a yellowish slough and surrounded by a bright red areola. Frequently they come out in successive crops, so that all stages can be seen at the same time. They are exceedingly tender, and if on a part where they are exposed to friction they may seriously interfere with mastication.

Aphthous stomatitis must not be confused with thrush, which is an entirely different affection.

*Ulcerative stomatitis*, which occurs at the same time of life and under the same conditions, is more serious. The whole thickness of the mucous membrane is involved (though not the substance of the cheek, as in norma); it becomes swollen, dusky-red, or even purple; then a foul grayish slough forms upon the surface; and later, when this is detached, a distinct although superficial ulcer is left. Very often the opposing surface of the gum or cheek, as the case may be, becomes infected too, so that various stages of the disease may be seen at the same time.

The symptoms depend upon the severity of the attack and the extent of surface involved. In the catarrhal form the mouth is hot and dry, the breath offensive and every movement of the tongue attended with pain; there is constant thirst and the sense of taste is altogether lost. After a time the secretion becomes more profuse, sometimes excessive, and very tender spots make their appearance, corresponding to the places from which the epithelium has been detached. In the ulcerative form these symptoms are greatly exaggerated; the gums are swollen and bleed with the slightest touch; the teeth are exceedingly tender, and movement so painful that mastication is impossible. Not infrequently there is a considerable degree of fever, and there may be conspicuous swelling of the floor of the mouth, involving the lymphatic glands and the loose cellular tissue around; but there is never the hard brawny feeling in the centre of the cheek which marks the onset of noma.

**Treatment.**—Chlorate of potash rarely fails to effect a cure: it should be given locally in the form of a gargle or wash, and internally as well. In younger children borax with glycerine (well diluted) may be painted over the raw surface several times a day; or, if the case is very obstinate, alum or nitrate of silver .10 ad 30 c.c. (gr. ij ad ℥j) may be used instead. The condition of the bowels always requires attention—it rarely happens that they are acting properly; but mercurials should be avoided; and as soon as a certain amount of regularity is established, tonics, iron, cod-liver oil and quinine should be given freely. Partly as cause, partly as consequence, these forms of stomatitis are always associated with debility and malnutrition. Other forms of stomatitis are due to specific causes.

*Thrush* is a superficial inflammation of the mucous membrane of the mouth and tongue caused by the growth in the epithelial cells of the fungus, the oïdium albicans, in all probability the same as the oïdium lactis. It is met with chiefly in children who are brought up by hand, and in adults suffering from exhausting illnesses. The mucous membrane of the mouth and tongue is red and swollen; its secretion is acid instead of alkaline; but the characteristic feature is the presence at the angles of the mouth of a number of minute white dots, without any red areola as in the case of aphthæ. These enlarge until they meet and fuse, so that sometimes in bad cases the whole of the interior, with the pharynx and even the

œsophagus, is covered over with a thick creamy-white layer. Diarrhœa with greenish offensive stools sets in; the child is unable to take any food; the emaciation becomes extreme; sores make their appearance round the anus, and the result is not unfrequently fatal.

This disorder is due to the fungus that causes the acid fermentation of milk, and can be produced anywhere by neglect of proper precautions, especially scalding thoroughly every time they are used all the vessels which contain food and come into contact with milk. In large institutions, such as foundling hospitals, it is constantly making its appearance unless special precautions are taken, and frequently helps to cause the death of weakly children by the digestive disturbances that accompany it.

The treatment is very simple: with thorough cleanliness it soon dies out. All suspicious spots within reach should be brushed over with very dilute carbolic acid, or with borax and glycerine, and the child's mouth cleansed thoroughly after every meal. At the same time the complications that are present with it, and are in great measure due to it, the diarrhœa, loss of appetite, and disordered digestion, require the strictest attention.

*Mercurial stomatitis* is rare at the present day: a faint red line, or a slight swelling of the gum round the necks of the teeth, particularly where there is an accumulation of tartar, is all that is seen. It may occur from inhalation, inunction, or absorption from the alimentary tract, and no doubt, though the number must be very small, certain people are peculiarly susceptible. The flow of saliva is increased; the gums, as already mentioned, become red and swollen; the breath is foul; the tongue furred and a little enlarged; the teeth feel too long; and mastication of anything hard is very painful. If this is persisted in the most fearful consequences may ensue; the mucous membrane may slough, the gums ulcerate away, the teeth fall out, the bones perish, and the gangrene spread to the floor of the mouth and nose, causing the most terrible destruction. In days gone by there is no doubt the result was often fatal, partly from the constitutional disturbance and the inability to take food, partly from the continued inhalation of particles from the foul and decomposing sloughs.

At the earliest sign the administration of mercury should be stopped, and strong astringent gargles used frequently. Usually this of itself is enough. Chlorate of potash is said to be of as great service in this as in other forms of stomatitis, preventing in particular the peculiar fœtor of the breath.

*Syphilitic Stomatitis.*—The same forms of eruption that occur upon the skin are met with also in the mouth, modified by the conditions under which they exist. They occur in the hereditary as much as in the acquired disease, and furnish a very large proportion of the cases of mediate contagion. Rhagades and the exceedingly painful fissures at the angles of the mouth have been mentioned already. Superficial sores, closely similar in appearance, are of common occurrence upon the inside of the lips. Mucous plaques and tubercles are more frequent upon the tongue, the tonsils, soft palate, and pillars of the fauces. Where the epithelium is thin, and the friction smooth and constant, they are scarcely raised; there is simply a grayish-white patch with a smooth surface, and well-defined, slightly reddened border; or the epithelial covering has already been detached and a raw surface left. Symmetrical patches of this kind are often seen upon the margin of the soft palate on either side of the uvula, and may be regarded as distinctive. In other places they grow out into warty or cauliflower excrescences, often of some size; and in others, again, where they are irritated by the teeth, they cut into deep and angry ulcers.

Secondary tubercular syphilides are more rare; the epithelium, which is thrown off as scales upon an exposed surface, becomes soft and macerated in the mouth, so that the appearance they present is closely similar to that just described. In the tertiary stage, superficial and deep gummata, involving the mucous membrane, the submucous tissue, or the periosteum, are of common occurrence. Sometimes they are absorbed under treatment, and disappear without leaving a scar; more

often they break down and leave deep and irregular ulcers. The favorite locality appears to be the palate. Central gummata, leading to necrosis and median perforation, are frequently met with (the presence of congenital clefts in the hard and soft palate, and occasionally of foramina in the pillars of the fauces, must not be forgotten), and it is not uncommon to find the uvula and soft palate either destroyed altogether or united to the posterior wall of the pharynx in such a way that there is only a small aperture left.

The constitutional treatment does not present any special features; the local is very important. Gummata disappear rapidly under iodide of potash; ulcers occasionally require the application of acid nitrate of mercury. Secondary affections, however, may prove very obstinate. The first thing is to get rid of every kind of irritant, whether it is the sharp edge of a tooth, or tobacco-smoke, spirits, or highly seasoned food. So long as these continue to act, it is almost impossible to effect a cure. Rhagades and exuberant condylomata may be touched with nitrate of silver, or brushed over with a 10 per cent. solution of chromic acid. Simple mucous patches usually get well with a wash of chlorate of potash and lotio nigra, or a very weak one of bichloride of mercury; in more obstinate cases the inhalation of calomel may be tried, or brushing the surface over, night and morning, with a solution of bicyanide of mercury (gr. xv ad ℥j), and sometimes iodoform lightly dusted on proves very beneficial, the taste and odor being concealed by mixing it with freshly ground coffee.

*Tubercular stomatitis* is not a common affection. Occasionally, when the tongue is involved, it occurs on the under surface of the soft palate, appearing in the form of minute vesicles which enlarge, break down, and leave superficial sores with sharply cut edges. More rarely it begins independently. There is very little inflammation as a rule; the sores slowly and steadily increase in size and depth, multiplying and fusing together until at length they develop into irregularly shaped ulcers with sinuous edges, often lying upon carious bone. There is no induration; the course at first is very chronic, and there are no large sloughs or necrosis, as in syphilis, but, in spite of this, the destruction may be very considerable; I have known the whole of the soft palate eaten away. The prognosis, especially when the disease is secondary to mischief elsewhere, is very unfavorable, and the course toward the end often very rapid, in a measure owing to the pain on deglutition, and the difficulty of taking food; but, occasionally, a certain amount of benefit is derived from constitutional treatment combined with scraping, iodoform, lactic acid, and similar remedies, and more rarely spontaneous (but unfortunately only temporary) cicatrization occurs.

Other forms of stomatitis are occasionally met with. Lupus may extend from the lips to the gums and palate, and has been known to occur independently; in the latter case the diagnosis from tubercular disease must be almost impossible. Anæsthetic patches occur in the early stages of leprosy, and deep ulceration is not infrequently the immediate cause of death in the tubercular form. A very acute variety has been described in connection with gonorrhœa; in scurvy, hemorrhagic stomatitis is one of the prominent symptoms, and in leucoplakia, when the tongue is extensively diseased, the mucous membrane of the sides and floor of the mouth is usually affected too.

## PERIOSTITIS AND OSTEITIS.

Inflammation of the superior or inferior maxilla may be caused by extension from neighboring structures, such as teeth; by injury after extraction of teeth or compound fracture; by mercury or phosphorus; by suppurative disease in all its forms (noma, acute suppurative periostitis, or, especially after the acute exanthemata, pyæmia), or by the action of specific organisms, such as those of actinomycosis, syphilis, tubercle, or leprosy. It may be acute or chronic, ending in necrosis or caries, according to the cause, the intensity of the attack, and the character of the bone. Necrosis, for instance, is more common in the lower jaw than in the upper,

owing to its peculiar density; caries in children, in whom the bones are more vascular and less compact. When due to acute suppuration, the sequestrum may be detached within a few days; on the other hand, in phosphorus necrosis, it often does not separate for years. The amount of new bone thrown out is usually very small, but in necrosis of the lower jaw from phosphorus poisoning it is often enormous for a time, and then disappears almost entirely.

In acute, suppurative osteitis, whether arising from local or constitutional infection, the symptoms are exceedingly severe. Owing to the vascularity of the part and the looseness of the tissues around, the swelling is usually excessive, spreading far over the face and down the neck. The fever is often very high and the pain intense, continuing until the pus is let out by incision or finds some means of exit for itself. Then the symptoms slowly subside, the pus escapes externally or into the cavity of the mouth, and the discharge continues until either the bone recovers (for even extensive portions of the alveolar margin may be detached from the periosteum by acute suppuration, without necessarily undergoing necrosis) or the sequestrum is cut off.

Mercurial stomatitis when carried far enough to affect the bones is no less acute, judging from past accounts, for happily such cases are seldom seen at the present day. Syphilitic inflammation, on the other hand, is more chronic, and the tubercular form more so still. Phosphorus necrosis is peculiar in many ways: it does not affect those whose teeth are sound, but as soon as a spot of caries appears the inflammation spreads down into the alveolus, detaches the gum, loosens the tooth, and steadily advances until the whole ramus is involved. The symptoms are often very severe: the soft tissues around swell up and become inflamed; there is a constant discharge of most offensive pus welling up around the teeth and poisoning the breath; fresh abscesses are always forming; and partly from the continued fever and inability to take food, partly from perpetually inhaling and swallowing the foul discharge, the patient is quickly reduced to a condition of extreme anæmia. (See *Diseases of Bone.*)

**Treatment.**—Syphilitic periostitis and simple acute inflammation are checked at once by iodide of potash, or by painting the inflamed surface of the gum with the liquid iodine. If there is the least reason to suspect suppuration, an incision should be made inside the mouth with a sharp-pointed bistoury, the edge of which is protected up to within half an inch of the end by wrapping it round with a strip of plaster. If this is done in time the disfigurement of an external opening can nearly always be avoided. Even when there is already a soft fluctuating swelling upon the face, the incision should always be made in the groove between the cheek and gum. Afterward the cavity of the mouth must be washed out frequently with some hot antiseptic solution (carrying it outside the teeth by means of a rubber tube), and the vessels of the skin made to contract by keeping it constantly wet with lead lotion. When dead bone is present, very little can be done until it is loose enough to come away. The teeth may be extracted if they are detached and surrounded by suppuration; incisions made to facilitate drainage; and the mouth kept as clean as possible. Carious bone may be scraped, but care must be taken, especially with children, not to disturb the germs of the permanent teeth. If any extensive defect is left, it must be bridged over with a suitable plate so as to preserve the outline of the mouth.

*Alveolar Abscess.*—Suppuration in connection with the fangs of carious teeth is known as alveolar abscess, or *parulis*. Throbbing pain, with protrusion of the tooth from thickening of the periodontal membrane, and swelling of the soft structures around the jaw, are the chief features. If left, it may discharge around the tooth; more often, it works its way out through the side of the jaw on to the gum (the ordinary form of gum-boil); but, when connected with the lateral incisors, it may spread back between the layers of the hard palate, and gain the surface first at its posterior margin, or burst into the nose, and, especially when the molars are involved, it has a marked tendency to open upon the face. In this case it is not unlikely to leave a chronic sinus, the orifice of which is surrounded

by pouting granulations. Sometimes, owing to the tension, the consequences are even worse; necrosis is not uncommon, and even pyæmia has been known to occur.

The mouth should be washed out with water as hot as can be borne, and the gums freely lanced, or leeched. Poultices should not be used. If this fails, and the tooth is much diseased, it should be extracted, or, if there is any stopping, this should be removed; but, unless this gives free exit, or the whole abscess sac comes away attached to the diseased fang, it is advisable to make a free incision through the swollen portion of the gum, keeping the edge of the knife turned toward the bone, and open the abscess there. The thickening along the side of the sulcus, sometimes extending under its floor, can usually be made out at once by running the finger round the inside of the cheek. If a discharging sinus persists, it will usually be found on probing that there is either a small sequestrum, or, more frequently, an old fang left, keeping up the irritation.

### Suppuration in the Antrum.

This may result from injury, from dental caries and alveolar abscess (the fangs of the first molar project into the cavity, and those of the second bicuspid are only separated by a thin plate of bone), or from disease of the mucous membrane of the nose. In this case the teeth are sound and free from pain, or are only involved secondarily, occasionally becoming loose and dropping out of themselves, from absorption of the alveoli.

The natural orifice of the antrum is rather high up on the floor of the middle meatus, and is rarely closed. Even when it is the inner wall is so thin that it usually gives way elsewhere. Sometimes, however, the secretion is pent up; the tension rises; suppuration sets in, and the attack becomes very acute.

When this occurs the pain is most intense; generally it is deep-seated; often it is referred to the teeth, and usually it radiates all over that side of the face and head. The walls of the cavity yield and bulge outward in all directions, as in the case of rapidly growing tumors. The side of the face is tender and swollen; the skin is reddened and pits on pressure; the nostril is blocked up; the teeth are loosened and exceedingly painful, very often they feel too long; and the floor of the orbit may be pushed upward, until vision itself is seriously interfered with. If the finger is passed under the upper lip, the anterior wall can be felt projecting into the mouth; and occasionally the bony plate is so thin that it crackles. Sometimes there is a rigor, and always there is serious constitutional disturbance. Such cases, however, are certainly rare; nearly always the wall gives way at some spot, and the acuteness of the symptoms is relieved at once; and it does not seem unlikely that most of the cases of acute suppuration of the antrum are really deep-seated periosteal abscesses in connection with the roots of the teeth, and are in the thickness of the wall.

In chronic inflammation, on the other hand, the occasional discharge of fluid from the nostril, when the patient lies down with the affected side of the face uppermost, is sometimes the only sign. If it is merely catarrhal, associated with polypi, the fluid is of a clear, watery character; if there is suppuration it is thicker and generally offensive; but it differs from ozæna in this, that the smell is perceptible to the patient, but not, unless by blowing the nose the cavity is emptied of its contents, to the bystanders. Moreover, there are no crusts of dried and inspissated mucus. Occasionally, the discharge finds its way through the posterior nares and is swallowed.

In one case quoted by Heath, the cavity was filled by thickened caseous pus, and the bone was enlarged, hard, and tender, so as to simulate a solid tumor of the jaw; as a rule, however, there is no distention. Attacks of neuralgia, with a constant, dull, aching pain, and sometimes frontal headache, as, when the frontal sinus is involved, are nearly always present. The teeth and the bone around are tender, and the former may become loose and drop out; the side of the face, and

especially the eyelids, are swollen and puffy from time to time; and, not uncommonly, the patient's health suffers severely from the constant swallowing of an offensive discharge.

When the suppuration is chronic, the diagnosis rarely presents any difficulty, though it is probable many of the cases are overlooked and regarded merely as inflammation of the mucous membrane of the nose. The acute form resembles in some respects a rapidly growing sarcoma, especially as this is often attended with pain and a considerable rise of temperature; but the symptoms are much more severe. In any case of doubt, an exploratory puncture should be made under the lip.

The treatment consists in letting out the pus, draining the cavity thoroughly, and, if necessary, washing it out with an antiseptic or mild astringent. In some cases, the cavity can be readily cleared from the middle meatus of the nose by means of a Eustachian catheter. If this does not succeed, an additional orifice must be made elsewhere. If any of the teeth which are ordinarily in relation with the antrum are decayed and carious, the stumps should be extracted, and, if the cavity is not opened, a trocar driven through the remaining portion of the bone, care being taken that it does not slip in too far. Afterward a drainage tube, that can be stopped at will, must be inserted in the opening to prevent its closing and to keep the food from passing up into the cavity, where it would decompose. If, however, the teeth are sound, or if they have already been extracted, and the alveolar margin has become thickened and dense from sclerosis, the opening must be made either through the anterior wall, under the upper lip, behind the canine, or through the nose. The former of these is to be preferred when the wall is at all bulged or is inclined to yield beneath the finger. The latter is better under other circumstances, provided there is sufficient room in the nostril. The opening is most easily made in the lower meatus, just under the middle of the inferior turbinate bone, where the inner wall is fairly thin. There is no difficulty in perforating the bone, and, if there is a necessity for it, the patient very soon learns to wash out the cavity through the opening, for himself. As a rule, however, if a second opening is made, and the interior is once thoroughly cleared of its decomposing contents, the secretion soon regains its natural character.

### Hydrops Antri, or Dropsy of the Antrum.

The facial surface of the upper jaw occasionally becomes immensely distended by a collection of clear yellowish serum containing a few crystals of cholesterin. The enlargement is very gradual, quite painless, and sometimes involves the palate and nasal surfaces as well. The bone becomes so thin that it crackles like parchment, and it may even be completely absorbed in some places. If the fluid is evacuated, the swelling subsides, the maxilla resumes its normal relations, and the opening very soon closes in.

It was formerly held that this dilatation was due to an accumulation of the natural secretion of the mucous lining of the cavity, the opening into the nose having in some way or other become closed. According to Heath, however, it is certain that some of these cases, and very probably all, originate as cysts in the anterior wall of the antrum; and that either they grow to such a size as to be mistaken for the cavity itself, or that the intervening wall is gradually absorbed by the pressure, and the two cavities thus placed in communication with each other.

### Closure of the Jaws.

Inability to open the mouth may arise from muscular spasm, from acute inflammation of the bones or soft structures, or from cicatricial contraction and other organic changes caused by previous attacks of inflammation.

(*a*) *Muscular.*—The simplest example is the contraction of the muscles of mastication, which not uncommonly attends the eruption of the wisdom teeth;

sometimes apparently it is hysterical, and, occurring as trismus, it is one of the early symptoms of tetanus. The contraction disappears at once under an anæsthetic, allowing the interior of the mouth to be thoroughly examined; and then, if the wisdom tooth is found to be growing forward against the next, or if it is covered in, steps may be taken to release it. Generally it requires removal, but occasionally this is impossible, and the next has to be taken away before it is sufficiently accessible. Hysterical contraction is characterized by the peculiar manner in which it returns after the anæsthesia is past, not slowly and quietly, beginning with the return of consciousness, but quite suddenly, long after all the reflexes, and not until the patient's attention is drawn to it.

(*b*) *Inflammatory.*—All forms of acute inflammation, whether involving the lower jaw itself, the tonsil, parotid gland, or other structures in the neighborhood, are attended by a certain degree of inability to open the mouth, partly owing to the pain, partly to the mechanical difficulty caused by the inflammatory exudation poured out in the loose cellular tissue. The treatment, of course, depends upon the primary cause.

(*c*) *Permanent Closure.*—This may arise from cicatricial contraction of the soft parts, consequent on noma or gunshot injury destroying a large portion of the cheek, or from affections of the joint. In one or two instances the coronoid process has become ankylosed to the upper jaw after long-continued inflammation. Unreduced dislocations, after a time, acquire considerable mobility, although the incisor teeth cannot be brought into apposition.

If the cicatricial contraction involves both the mucous and cutaneous surfaces, the only satisfactory way of dealing with it is by plastic operation after excision. Stretching the bands and simple division are quite useless. A double flap must, of course, be used—the inner one, if possible, being composed of mucous membrane. In cases in which the whole thickness is not involved, Heath recommends that the cicatrix should be freely divided and a metal plate or shield adjusted on the teeth so as to fit in between the gum and the cheek, and prevent the formation of fresh adhesions. A kind of mucous membrane is gradually developed in the groove, but this mode of treatment is naturally only practicable in a very limited number of cases.

*Ankylosis of the lower jaw* is caused either by chronic suppurative arthritis (consequent on injury, pyæmia, suppurative osteitis, or tubercular disease) or by a peculiar form of rheumatism, often the relic of an acute attack, which leads to the production of dense fibrous adhesions, and not unfrequently obstinately returning again and again, ends at length in synostosis. Naturally, it is a condition of considerable importance, not only from the interference with mastication, but from the grave danger of asphyxia in case of vomiting.

**Treatment.**—The joint may either be excised or an artificial one made in front of the fixed point. The former operation is only of limited value. An incision an inch and a half in length, not deeper than the subcutaneous cellular tissue, is carried downward and slightly forward from the supraglenoid root of the zygoma. The temporo-facial branch of the seventh nerve must be found and pulled downward, the lobules of the parotid gland pushed aside, and the neck of the condyle divided with a chain saw, without opening the buccal cavity. The head may then be detached with a chisel or cutting-forceps, and levered out; but, especially in those cases in which the bones are dense and sclerosed as a result of chronic osteitis, the operation is exceedingly difficult.

Linear osteotomy has been performed through the condyle itself; below this through the neck; further down at the base of the coronoid; and, according to Rizzali's method, through the mucous membrane, without an external scar; but all of these labor under the same objection, that osseous union is almost certain to occur.

Esmarch's operation (excision of a wedge-shaped portion of the ramus) is more satisfactory. An incision is made along the lower margin, in front of the angle, the soft parts separated, and a triangular portion of bone with its apex

upward, and the base, about an inch in length, corresponding to the lower border, detached and removed. A deep groove is cut on the external surface with a saw first, and then the section completed with cutting forceps. Bennett, who performed this operation on both sides in a case of rheumatic synostosis, in which all milder measures had failed again and again, recommends that, at least in cases of this disease, the insertion of the masseter should be detached from the bone on the distal side of the incision, or the two fragments are certain to be drawn together. The patient recovered with very good upward and downward action.

## TUMORS.

### 1. In Connection with the Soft Structures.

*Nævi* are not uncommon upon the gums, lips, and inside of the mouth. In one case under my care the whole thickness of the cheek was involved.

*Congenital hypertrophy* of the gums is a very rare affection, requiring free excision. It must be distinguished from local hypertrophy, growing out in a polypoid form, the result of constant irritation, for which a much more limited operation will suffice.

*Papillomata* may occur upon the gums in the neighborhood of the teeth, upon the lips, or upon the inside of the cheek. In some cases they are low and can scarcely be distinguished from ordinary warts; in others, however, they are compound or branched and covered over with exaggerated filiform papillæ, similar to those that are occasionally seen in what has been called ichthyosis linguæ. It is probable that they are the product of constant irritation (I have known them develop symmetrically upon the upper and lower lips, from perpetual smoking); and they should always be freely removed for fear of something worse developing as age advances.

*Adenomata* are rare, but they are occasionally found on the lips, palate, gums, and, in short, in all parts in which mucous glands are abundant. They form soft, irregularly-shaped, but flattened swellings under the mucous membrane. Their growth is slow, but it is generally difficult to ascertain how long they have been present. In microscopic structure they present a close resemblance to the gland growths that are found in the parotid, and sometimes, like these, are cystic and contain bone and cartilage. For the most part they are made up of irregular masses of acini and ducts.

*Mucous cysts* are often met with upon the inside of the lip (labial) or cheek (buccal) developed from the mucous glands, and forming rounded, tense swellings, rather dark in color. The contents are translucent, but very viscid; and occasionally undergo calcareous degeneration. It is sufficient to remove a portion of the wall, but in many cases the whole can be excised without difficulty.

*Ranula* is the term applied to a cyst of the floor of the mouth, in many respects resembling those just described. It forms a soft, lobulated, fluctuating swelling, usually of a bluish-purple color, and lies immediately under the mucous membrane, on one side of the frænum linguæ. When small it gives rise to little inconvenience, but as it grows it pushes the tongue on one side, interfering with deglutition and articulation, projects in the submaxillary region, and may even reach down into the neck. The wall is composed of fibrous tissue lined with epithelium which is sometimes ciliated; and the cavity is filled with a clear viscid fluid that bears no relation to saliva.

Ranula is probably developed from a mucous gland (that of Blandin or Nuhn) which is present in this situation; it has nothing to do with the duct that runs by the side of it. It has been known, however, to originate in connection with the sublingual gland, and it is probable that in many doubtful instances it is the product of cystic dilatation either of normal mucous glands occupying this region or of outlying portions of the larger ones which have been in some way detached

in the course of development. It is very questionable whether ranula in the strict sense of the term ever develops from the sublingual bursa, although it is quite possible that this may become cystic.

The treatment of ranula is a little difficult on account of the obstinacy with which it returns. Excision of the whole cyst is a serious operation, involving a considerable degree of dissection among very vascular structures. Removal of a portion of the wall only is seldom of any use unless further steps are taken to secure its obliteration. So much may be cut away that it cannot close; the interior may be wiped out with caustic, so as to excite a certain degree of inflammation; a V-shaped flap may be made and the apex stitched down to the floor; or a wire or silk seton may be used. The milder measure should be tried first, as severe inflammation may result if the sac wall is made to slough.

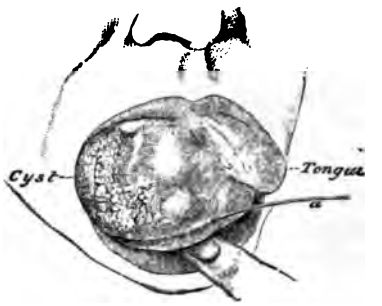


FIG. 335.—Ranula, or Sublingual Cyst, with Salivary Duct lying upon it.

[The injection of Tincture of Iodine is recommended. After the excision of the V-shaped flap a hard-rubber syringe with a long curved nozzle should be pushed into the cavity, which should then be filled to distention with the iodine. A second and even a third injection is sometimes required.]

*Dermoid Cysts.*—Cysts containing sebaceous matter and hairs are occasionally found in the floor of the mouth, chiefly in the middle line, and in the substance of the tongue. They are always of congenital origin, although they may not enlarge until adult life, and are due either to accidental implantation, or to the persistence and cystic degeneration of fœtal structures, such as the hyoglottic canal, which commences at the foramen cæcum. Their position, the absence of inflammation, and the exceedingly slow enlargement are the chief diagnostic features, but it is rarely possible to be certain without a preliminary puncture.

Other forms of cysts are very rare, although one or two instances of hydatids are on record.

*Epithelioma* (squamous) is the only form of malignant disease that is at all common. It develops not unfrequently from the continued irritation of ill-fitting plates, and requires the freest removal. The diagnosis from simple ulceration is not difficult if the part is examined carefully, but the chief interest of this disease is the relation that it bears to a variety of cystic degeneration of the jaws.

### 2. GROWING FROM THE BONES AND PERIOSTEUM.

Partly owing to the great variety of the tissues that compose them, partly to the constant irritation to which they are subjected, the jaws are exceptionally liable to become the seat of new growths and cysts. All the tumors that develop in connection with bone may occur, and, in addition, others that form from the teeth, the fibrous tissue of the gum, and the epithelium. The term *epulis* is applied to those that grow from the alveolar margin at the neck of the teeth, springing from the periosteum or the periodontal membrane. Strictly, it should be limited to the hard fibromata which are common in this region, and which often extend so far down the socket of the tooth that a considerable portion of the alveolar margin has to be excised in order to insure its complete removal.

*Fibromata*, composed of peculiarly dense fibrous tissue, with often spicules of bone, and sometimes islets of cartilage in their anterior, are the most common. For the most part they grow from the periosteum and form pedunculated tumors, projecting under the mucous membrane. More serious ones, however, are met with occasionally, springing from the interior of the antrum, or from the inferior dental canal, or from the sockets of some of the teeth, and attaining an enormous

The treatment consists in free incision of the cavity, exploration to make sure there is no persisting cause, such as a misplaced or supplementary tooth, and drainage.

According to Heath, periosteal cysts occur in the lower jaw without any apparent immediate connection with the teeth, though very possibly some irritation connected with those organs may have been the original cause of the mischief.

Cysts that develop in connection with myeloid or other sarcomata rarely admit of diagnosis, and do not possess any practical importance.

*Multilocular cysts*, on the other hand, the so-called cystic sarcomata, are of great interest. They are more common in the lower jaw than in the upper, and originate, in most instances, in some form of injury, or from the irritation of decayed teeth. Formerly they were regarded as simple cysts, but it has been shown that they are really of epithelial origin, due to the downgrowth of columns of cells from the surface into the interior of the bone. As a result, great cellular spaces are formed inside, and the internal and external plates are so far separated from each other that in extreme cases the alveolar portion of the horizontal ramus is reduced to the condition of a few scattered trabeculæ, and the teeth are completely detached. The central cells in the larger columns undergo colloid degeneration, and in this way cysts are formed, filled with a thin, glairy, or blood-tinged fluid, and surrounded by imperfect layers of columnar epithelium. Their growth is very slow, and, probably owing to the bony capsule and to the early degeneration of the epithelium, they have but little tendency to implicate surrounding structures or the lymphatic glands. In one or two instances, however, sarcomatous tissue has been found associated with them, and then the prognosis is not so good.

Owing to the fact that the alveolar margin and the sockets of the teeth are much more involved than the lower, firmer portion of the horizontal ramus, it is possible, in many cases, to excise the whole of the growth from the mucous surface, scraping it away freely, without removal of the whole thickness of the bone. Whether this should be done or not depends chiefly upon the age of the patient and the amount of solid tissue present. In case of any recurrence, the whole affected portion should certainly be removed.

## OPERATIONS ON THE JAWS.

### Excision of the Upper Jaw.

This may be complete or partial, not removing the floor of the orbit. Where possible the latter is to be preferred, as it causes less deformity and does not expose the eyeball to the risk of displacement or injury. In cases of sarcoma, for which this operation is most frequently performed, free removal of every part of the bone is essential.

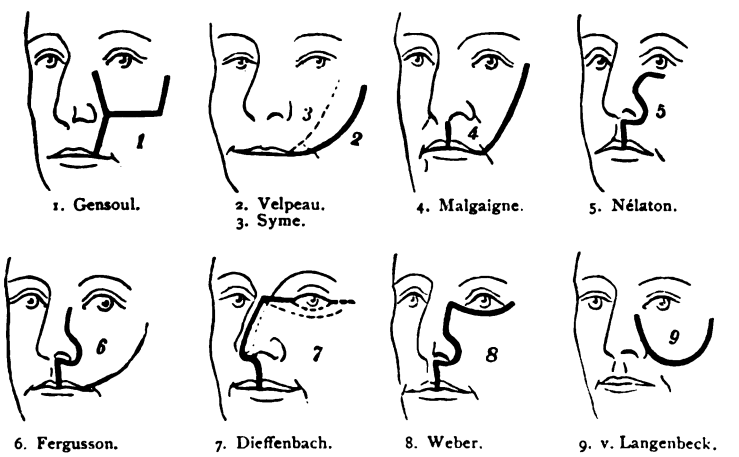
The patient is placed in a semi-recumbent position with the head and shoulders well supported. The anæsthetic must be administered by means of Junker's apparatus, the tube being passed through the other nostril or the mouth, according to the convenience of the moment. A preliminary tracheotomy is not necessary, although it is a wise precaution when a hemorrhage is expected, but the administrator must pay special attention to the breathing, and particularly to the danger of blood finding its way down the larynx.

The incision (usually known as Fergusson's) runs down the centre of the upper lip, round the ala of the nose to the inner angle of the orbit, and along its lower margin as far as the malar prominence. The arteries of the lip are the only ones that bleed, unless the growth has infiltrated the skin. The flap is reflected far enough to expose the whole of the bone that requires to be removed.

An incisor tooth is drawn, and an incision made with a stout scalpel along the floor of the nose, down the hard palate in the middle line, and transversely outward at its posterior margin toward the last molar. The object is to preserve

soft palate when the bone is removed, the separation being completed with blunt-pointed scissors. The ala of the nose and the periosteum of the orbit are to be detached in the same way.

The bones may be partially divided with a saw or cut through at once with a pair of long-handled bone-forceps. The latter is the more speedy and does not really lead to more splintering. One blade is passed into the mouth, the other down the nostril, and the hard palate divided with a single cut; the nasal process is treated in the same way, and then the outer angle of the orbit, the line of division running into the spheno-maxillary fissure. By this the bone is practically freed, and if grasped with a pair of lion-forceps, one set of teeth fixing themselves in the hard palate, the other on the malar eminence, it can be easily detached by wrenching it from side to side, and separating the soft structures as they resist with a pair of blunt-pointed scissors. There is seldom any hemorrhage; the arteries divided are all minute, and if torn across retract at once. Sometimes, however, when the growth is very rapid and the vessels much dilated, it is fairly free; and if the substance of the tumor (in which the vessels are often little more than open channels) is torn, it may be of any extent. It must be stopped by pressing a sponge firmly against the bleeding part, or, if this fails, with the actual cautery.




1. Gensoul. 2. Velpeau. 3. Syme. 4. Malgaigne. 5. Nélaton. 6. Fergusson. 7. Dieffenbach. 8. Weber. 9. v. Langenbeck.

FIG. 336.—Incisions for Section of the Superior Maxilla.

If the whole growth has been removed and the bleeding stayed, nothing further need be done; the flap is simply replaced and fixed with two or three sutures, a hare-lip pin being used for the lip. If, however, the bone is crushed by the forceps, or if the surface of the growth presents a torn and ragged surface, the wound must be carefully examined, and the rest either removed with a sharp spoon or destroyed by packing the cavity with lint covered with a paste made of chloride of zinc and starch. Sometimes it is necessary to plug the space with strips of iodoform gauze in order to check the oozing; but, whatever material is used, it must be withdrawn at the end of twenty-four hours, owing to the rapidity with which it becomes foul, and partly for this reason, partly from the pain it causes, it should be avoided whenever it is possible.

The after-treatment is very simple and the deformity left strangely slight. The lower eyelid, however, may become œdematous, especially when the floor of the orbit is removed, and cause a very unsightly projection; and, in cases in which it is necessary to remove the malar bone as well, the prominence of the cheek, of course, is lost, so that the depression becomes more conspicuous.

Partial operations are much more common. The floor of the orbit may be left, the bone being sawn across below the infra-orbital foramen; or the incision

may be confined to the side of the nose, and the anterior wall of the antrum exposed sufficiently to allow a tumor to be gouged out from the interior; or large portions of the alveolar margin with the teeth may be removed from the inside of the mouth in cases of epulis. Temporary resections, in which more or less of the bone is separated from the rest and reflected, without dividing the periosteum or soft tissues, have been described on page 758.

### Excision of the Lower Jaw.

This may be either complete, the symphysis being divided and the condyle disarticulated, or partial; and it may be performed altogether from the inside of the mouth, or through an external incision. The former operation, except in the case of such diseases as phosphorus necrosis, is exceedingly difficult and dangerous from the risk of wounding the facial and maxillary vessels in a part that is almost inaccessible from the interior; the latter involves a cicatrix of some

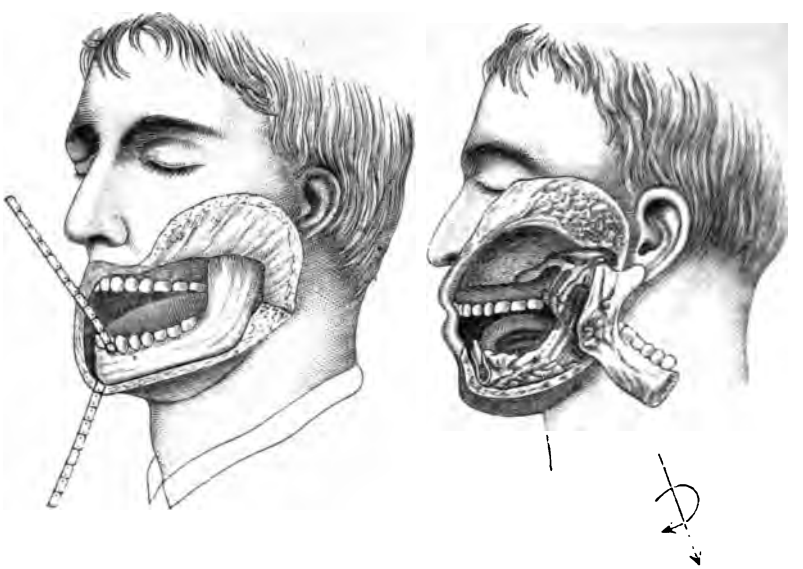


Fig. 337. Resection of Lower Half of Jaw. Fig. 338.
Cutting the Skin and Sawing Through the Bone. Twisting from the Joint.

extent (depending upon the amount of bone that requires taking away), but if the red portion of the lip is not divided, and the incision is kept under the horizontal ramus it is scarcely noticeable. The facial artery must, of course, be divided, but the nerve does not suffer unless the incision is carried unnecessarily high up the posterior margin of the vertical ramus.

If one-half of the bone is to be removed, a vertical incision is made through the lip, and a horizontal one at right angles to this, along the inferior margin as far as the angle, and up behind the vertical ramus to a level with the lobule of the ear. The soft tissues are dissected off the external surface of the bone and reflected upward; the jaw divided near the symphysis, one of the teeth being drawn for the purpose, and the structures on the inner side separated in the same way. The bone should be sawn nearly through and the section completed with bone-forceps, and care should be taken when the division is near, and still more at the symphysis, that the tongue does not fall backward. The facial artery should, of course, be secured at once.

The anterior end of the detached half must now be grasped with forceps, and pulled down to complete the separation of the masseter and internal pterygoid. For the latter the bone must be everted. Then, if it is intended to disarticulate, either the temporal muscle must be detached from the coronoid or this process cut off with bone-forceps and left for excision later. If it catches against the malar bone while it is being depressed this must be done. As soon as this is effected, the jaw can be depressed a great deal further, and by keeping the point of the knife well against the bone the long internal lateral ligament (with the inferior dental nerve and artery), the capsule and part of the external pterygoid can be divided. The jaw then comes away readily, the rest of the soft structures being divided, one by one, with blunt-pointed scissors. Great care is required not to divide the internal maxillary artery, which lies outside the internal lateral ligament, between it and the bone, or to tear it by everting the ramus too much and twisting it round the neck of the condyle.

Partial excision, leaving the condyle and the coronoid process, is more easy. In many instances slighter operations still are possible: a segment of the horizontal ramus only may be removed (when this is done the division of the jaw should be nearly completed in both lines of section before either is carried right through, or in making the second the support of the jaw is lost); or, as in epulis, and occasionally in epithelioma, the alveolar portion may be taken away and the lower border left.

teeth, and movement is attended with severe pain. If the inflammation continues the swelling soon becomes enormous; the tongue fills the mouth, protrudes between the teeth, presses up against the palate and projects backward over the glottis. The tissues at the floor of the mouth become swollen and tense, so as to raise it further still; the mouth cannot be shut; the saliva pours away; articulation and deglutition are impossible; and there is imminent danger of asphyxia. The pain in acute cases is very great and there is dreadful distress, but the temperature is seldom high. As the inflammation subsides, superficial sloughs not uncommonly make their appearance where it has pressed against the teeth, leaving troublesome ulcers; or this is followed by a condition of chronic induration and enlargement; or, in very rare cases, by persistence of the sloughing, until, if the patient does not succumb from septic poisoning and broncho-pneumonia, the whole organ is practically destroyed.

The treatment depends upon the severity of the attack. In the milder cases, in which the distress is not urgent and there is no immediate fear, the bowels should be opened freely with a saline purge, chlorate of potash given internally, and the mouth washed out constantly with an ice-cold solution of carbolic acid or permanganate of potash. Fragments of ice may be sucked meanwhile. In the more severe ones, when the mouth is nearly filled, leeches may be applied behind the angles of the jaws, and careful examination made with the finger over the dorsum of the tongue as far as it will reach. If a special projection can be felt, or even if there is merely a difference in consistence, a puncture should be made with a scalpel, either on the dorsum in the middle line, or below, through the floor, according to its position, and a further exploration made with a steel director in the hope of finding a circumscribed abscess. In the most severe cases, however, nothing of the kind is possible, and all that can be done is to make a free incision down the dorsum of the tongue on each side of the middle line, about half an inch from it, and offer a chance of escape to the inflammatory effusion. The depth need not be great, but the submucous tissue should be opened up. Afterward the patient usually requires a prolonged course of tonics. Acute glossitis rarely occurs except in those whose health is already broken down, and its course is so rapid and so severe that death may ensue simply from exhaustion. Tracheotomy may be required at any moment.

### *Simple Ulceration.*

This is usually caused by friction against the edge of a tooth or plate; but the liability to its occurrence and its severity depend very largely upon the state of health at the time.

The sore is generally situated at the side or under the tip; it may be single or multiple, according to the cause. When quite recent there is merely a superficial blister or excoriation, surrounded by a narrow zone of redness. In older cases and when the irritation is severe, it is more like a deep cut, extending into the substance of the tongue, with a sloughy surface and sharply-defined angry edges. The dorsum near it is covered with fur; the mucous membrane around is swollen and œdematous, so that the sore appears raised above the level of the rest; the breath is offensive, and movement very painful. In very chronic ones the appearance is different again. The signs of acute irritation, the redness, swelling, and sloughing base are wanting; and in their place there is an amount of induration that suggests epithelioma at once. It is in these that Butlin's method of examining a scraping from the surface (if cocaine is used a considerable thickness is easily obtained) is chiefly useful, and it should always be tried when there is the least suspicion.

The diagnosis rests chiefly upon the position, the signs of inflammation, and the evidence of an exciting cause If this can be found and removed, either by filing down or extracting a tooth, or by covering over a sharp projection with a shield of vulcanite, the irritated surface soon loses its redness and begins to granulate. Borax, chlorate of potash, and a lotion of chromic acid (gr. x. ad ℥j) are

the most useful applications. If, however, the sore is indurated, in a person over forty years of age, and if improvement does not very soon take place, a further examination should be made, and unless it is perfectly satisfactory, there should be no hesitation in excising the whole affected area. Ulcers of this kind frequently leave fissured cicatrices extending some depth in the substance of the tongue.

### *Chronic Superficial Glossitis.*

The surface of the tongue is liable to a peculiar variety of inflammation which is of great importance, owing to its obstinacy and to the tendency to pass on to epithelioma. It is known by many names, and assumes many forms, but there is no evidence to show that there is any essential difference between them. A single patch is sometimes spoken of as *leucoma;* the term *chronic superficial glossitis* is usually reserved for that condition in which the whole surface is smooth and red-

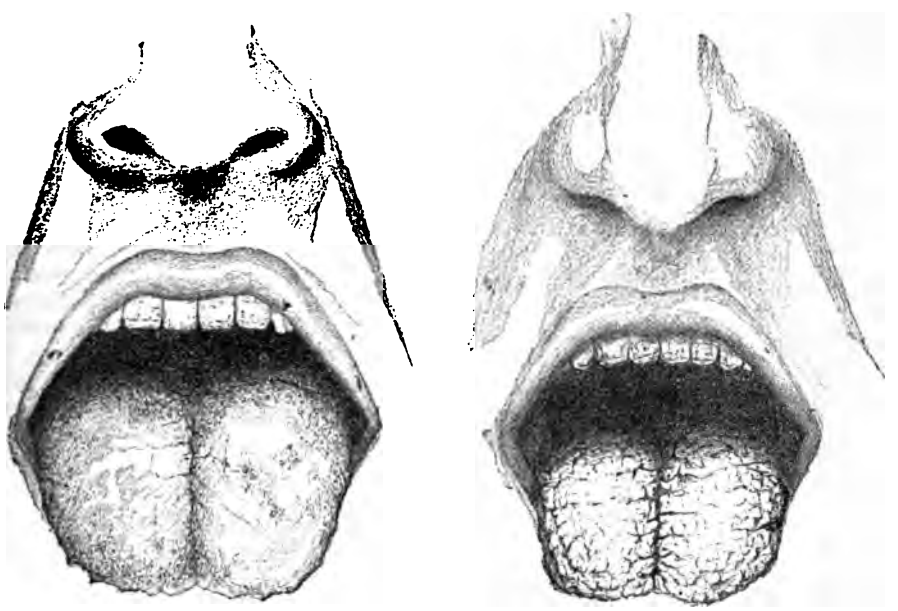


FIG. 340.—Chronic Superficial Glossitis.

1. The early stage, with slight enlargement.

2. The later stage, with dense coating of epithelium, cracked and fissured.

dened, the papillæ having disappeared; when a large portion is covered with a thick milk-white mass of sodden epithelium, it is called *leucoplakia;* a very rare condition, in which the filiform papillæ, over more or less of the surface, are enormously hypertrophied, may, with some reservation, be spoken of as *ichthyosis* (it is not a congenital affection like true ichthyosis, but merely an inflamed papillomatous growth); psoriasis, tylosis, keratosis, and other similar expressions are not needed.

It is much more common in men than women, and rarely occurs under forty years of age. Tobacco smoking, raw spirits, hot and irritating articles of diet, and syphilis are usually regarded as the causes, and there is no question that in the majority a perfectly definite history of one or all of these can be obtained; but it is equally true that it occurs sometimes in patients who have never suffered from syphilis and who have never smoked or drank to excess. In some the whole surface soon becomes involved, and these must be regarded as in some way specially predisposed to it; in others it remains limited to small patches for a great length

of time, but it always begins opposite some irritant, either a tooth or the spot at which the end of a pipe rests. It is exceedingly common among dock laborers at the East End, and I believe is due chiefly to smoking, and very possibly to the kind of tobacco.

The appearances differ immensely in different stages. In the earliest, one or more spots upon the surface are smooth, glossy, and redder than the parts around. The mucous membrane is hyperæmic and œdematous, the horny layer of the epithelium is detached, and the natural inequalities of the surface are leveled up. The swelling is not noticeable unless a considerable portion of the tongue is involved; then the increase in size is shown by the deep depressions for the teeth all round the edge (Fig. 340). By-and-by, as the epithelial layer continues to grow, bluish-white, semi-translucent patches make their appearance here and there; gradually these become thicker and more opaque in the centre, and spread further and further round the margin, until at length, if the irritation continues, the whole surface is covered over with a sodden layer like the epidermis of the hand after it has been poulticed. Before this stage is reached other changes begin. The dense covering of epithelium, like sodden wash-leather to look at, impedes the movements of the tongue; its flexibility is lost; often it shrinks in size and becomes hard and dense; deep cracks and fissures form, arranged longitudinally and transversely in a symmetrical pattern; and, after a while, as these become more and more worn, ulceration follows. In severe cases the inflammation is seldom limited to the tongue itself; not unfrequently the white patches extend over the floor of the mouth, and on to the lips and palate as well.

The ichthyotic variety is very rare in comparison. It originates as an inflammatory overgrowth of the papillæ at one or more points. They grow out and form rugged thorn-like masses covered with sodden layers of epithelium, but do not apparently infiltrate the deeper layers to the same extent. It usually occurs upon the tongue, but I have seen a typical example upon the inner surface of the upper lip caused by persistent smoking.

The symptoms of which the patient complains are very slight. There is a certain amount of discomfort, but it comes on so slowly that it is scarcely noticed. The tongue is tender; in the later stages it feels uncomfortable and stiff, and the sense of taste is impaired, but unless the surface becomes ulcerated opposite a tooth or deep down in one of the fissures, there is rarely any actual pain.

The prognosis, except in the slighter cases, is very unfavorable. Partly, no doubt, this arises from the fact that the same causes are usually allowed to continue at work, although, perhaps, with a less degree of intensity; but, independently of this, treatment has singularly little influence, if once the epithelium has definitely become opaque. What proportion of these cases end in carcinoma is very uncertain; according to Butlin, the number is probably under-estimated. Sometimes an ulcer or a fissure becomes the seat of malignant disease, the column of epithelium growing down into the subjacent layers, as in other parts of the body; but not unfrequently it develops simultaneously over a large extent of surface in cases in which the leucomatous condition of the tongue has ever been sufficiently marked to attract attention.

**Treatment.**—All sources of irritation should be removed at once; diet must be carefully regulated, and smoking prohibited; it is clearly impossible even to procure relief if the causes are allowed to continue. The rest is simply palliative. Mercury and iodide of potash very rarely effect any good. Local washes of bicarbonate of potash or borax are sometimes beneficial; in other cases chromic acid or dilute bicyanide of mercury painted over the surface once or twice a week answers better. Caustic should never be used, but localized indurated patches or obstinately persisting ulcers may sometimes be excised, even though there is at the time no evidence of malignant disease.

### *Syphilitic Affections of the Tongue.*

Primary chancre is very rare, but it may occur, usually near the tip. The induration is always well marked, and this, together with the age of the patient, the rapid enlargement of the glands, and the influence of treatment, is the chief diagnostic feature.

Mucous patches are very common, and present immense variety. On the dorsum they form flattened elevations of a grayish-white color, smooth or slightly papillated on the surface. There is no red areola surroundimg them and they are not sensitive. Under the tongue they grow out into low, cauliflower-like projections. At the tip and margin where they are irritated by the teeth, they develop into ulcers. Sometimes these are superficial, but often, if there is a ragged edge, they extend deeply into the mucous and submucous tissue, leaving irregular fissures and cicatrices when they heal. In many cases it is very difficult, if not impossible, to distinguish these from simple traumatic ulcers, except by their persistence, and by the slight degree of inflammation around them.

In the later stages syphilitic inflammation is almost as common. Sometimes it takes the form of a rounded gumma deep in the substance of the tongue, forming a soft, ill-defined swelling, usually projecting on the dorsum in the middle line. This may be absorbed and disappear under treatment, leaving a buried cicatrix which, without implicating the surface, entirely destroys the shape; or it may break, like any other gumma, and form a sloughing cavity with overhanging ragged edges. In other cases the exudation is more diffused, and numerous small tubercles are developed one after the other, leaving irregular sores and radiating scars. Sometimes, again, hard patches make their appearance in the mucous and submucous tissue, and grow larger and larger until they form definite elevated plaques, the surface of which loses the papillæ, becomes dense and white and then breaks down into irregular ulcers and fissures; and occasionally what is known as sclerosing glossitis sets in; the substance of the tongue is infiltrated more or less throughout; the natural tissue elements are destroyed, and an uneven, fissured, hardened, and distorted mass is left. As these different forms rarely or never occur by themselves, and as they are nearly always complicated by leucomatous patches and ulcers caused by the teeth, the ultimate result in a tongue affected by severe syphilis can hardly be described; the shape is altogether altered; few or none of the papillæ are left; deep fissures traverse the surface in all directions; hardened elevations, covered with dense, white epithelium, project between, and ragged, irregular, and painful ulcers are scattered around the margins and at the bottom of the clefts.

**Diagnosis.**—The induration in syphilis is rarely so dense or so well-defined as in epithelioma. Other signs are of little value in comparison. Both diseases are common at the same time of life, although, of course, syphilis may occur earlier. If the sore is on the dorsum, if there is little pain on pressure and little salivation, it is probably due to syphilis; but it is impossible to say more, as one so often develops from the other. If there is the least doubt, a scraping from the surface should be examined under the microscope. Iodide of potash not unfrequently causes a temporary improvement in typical malignant cases (possibly, because of the syphilitic foundation), and care must be taken not to be misled by this.

**Treatment.**—The constitutional treatment of syphilitic glossitis is most important; but at least as much care must be paid to local conditions. The mouth should be washed out frequently with a gargle of chlorate of potash and lotio nigra, or of very dilute bichloride of mercury. Obstinate patches should be painted over every day with chromic acid (gr. x ad ℥j), or bicyanide of mercury (gr. xv ad ℥j). Iodoform, if the patient can stand it, is especially valuable for deep ragged ulcers; but caustic, which stops almost immediately the progress of fissures at the angles of the mouth, should never be used in the case of the

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FIG. 341.—Epithelioma of the Tongue.

for it to develop at the seat of an old gumma, or even directly
cer; but not one of these things, nor all of them together,
explanation for its growth. It may spring from any ulcer,
n any scar, or any part of the tongue that is irritated, whether
stic, and even in some cases apparently from a healthy surface.
nce is equally variable, depending upon the condition of the
rs. There may be merely a little induration at the base of a
the floor of an ulcer or fissure; a leucomatous patch may
hick and dense, or a nodule may form quietly without being
ance of the mucous membrane. Naturally, from the causes
occurrence, it is more common on the edges and at the tip;
. However it forms, when it is first seen it usually has already
f an ulcer; the epithelial surface has broken down, and an
with a sloughing base, is already developed. The only constant
tion due to the accumulation of the epithelial growth.
irregular, raised above the surrounding part, and intensely
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r example, it originates from a papilloma or a superficial leu-
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growth, the disease extends to the floor of the mouth or along the arches of the palate to the tonsil; the tongue becomes fixed, and even the bone at length involved. When this stage is reached the suffering becomes intense; speech and swallowing are almost impossible; the pain never ceases; salivation is profuse; the mouth is filled with a foul, sloughing ulcer, and the strength fails rapidly. Death usually takes place in a year or eighteen months. The constant pain, the want of food and sleep, the hemorrhage from the ulcers in the floor of the mouth, and the suppuration and sloughing speedily bring on the most profound exhaustion. Sometimes this alone is sufficient; in other cases the immediate cause is an attack of bleeding rather worse than usual, or what is more common still, septic pneumonia, due to the inhalation of particles from the foul and putrid surface. It is noteworthy that secondary deposits, other than those in the glands and floor of the mouth, are not so common in this variety of carcinoma as in many others.

**The diagnosis** in the early stages is often very difficult. Papillomata, syphilitic and tubercular ulcers, and those due to chronic irritation, all bear a close resemblance to carcinoma, and not unfrequently pass into it; while it must be always remembered that the clearest evidence of syphilis does not preclude in the least the presence of carcinoma too; some would even go so far as to say that it is actually in favor of it. If there is the slightest induration, a scraping should be examined, and unless the absence of epithelioma is proved the sore should be excised. Small operations of this kind are not in any way serious, while the risk on the other side is fearful. As already mentioned, no reliance can be placed on temporary improvement under the influence of iodide of potash.

**Treatment.**—Early removal is at present the only hope of cure. It is true that the percentage of cases that have lived for more than a year without recurrence is very small, but when it is recollected that hospital patients (and many private ones) often do not apply for treatment until months have passed, and that then they frequently will not submit to operation until some other remedy has been tried and failed, the blame should not be laid upon the operation. It is certain that in cases of early and thorough removal, not only is the immediate mortality very much less, but the period of immunity very much longer.

When, owing to the position or extent of the growth, there is no chance of complete removal, or when the carcinoma has returned, much can still be done to relieve suffering. Excision of the growth is certainly justifiable if it offers a hope of relief from pain; the stump of the tongue sometimes remains healthy, even when the operation is too late to intercept the glandular enlargement. In exceptional cases parts of the surface may be destroyed with the actual cautery, if only the painful spot is limited in extent; but discretion must be used, as ineffectual cauterization only makes the growth tenfold more rapid. The lingual nerve may be divided; this nearly always stops the pain and salivation at once, although, unless a portion is resected, the benefit is only for a time. In most cases, however, especially toward the end, morphia is absolutely necessary, and if it is given it should be given freely. Butlin recommends dusting the surface with a powder composed of iodoform, borax, and morphia.

The fœtor, which is very distressing, must be checked with iodoform, or washes of permanganate of potash, dilute carbolic acid, or other antiseptics. A small quantity of cocaine may be added if the smarting is severe. Inhalations of eucalyptus and creasote are also very useful. If there is any hemorrhage it must be checked by local pressure, ice, or the application of styptics. The feeding of patients suffering from epithelioma of the tongue in its advanced stages is always difficult. Mastication is impossible; the pain is so intense when anything touches the tongue that deglutition can hardly be carried out; and later the larynx is often insufficiently protected. So long as swallowing is possible the food should be carefully prepared beforehand; but in many cases the patients after a little while prefer to feed themselves by means of a funnel and soft rubber tube. Toward the end even this may be impossible, and it may be necessary to pass a tube through the nostril or make use of nutrient enemata.

## OPERATIONS UPON THE TONGUE.

Removal of the tongue may be accomplished through the mouth, with or without previous division of the cheek; or through the floor after a varying amount of dissection. Division of the jaw itself adds very greatly to the gravity of the operation, without—unless the disease has involved the bone—any commensurate advantage.

The choice of operation is naturally influenced chiefly by the seat of disease. If the growth is very recent, little more than a suspicious papilloma, and near the tip, a very small operation through the mouth may suffice. If it is more advanced, the whole tongue can be removed without external incision; but if either of the glands is involved, or it is thought (and there can be little doubt about it) that the patient stands a better chance by removing not only the tongue itself but the lymphatic tissues on the floor of the mouth, a submaxillary incision is essential. Removal of the anterior half is not necessarily a serious operation: removal of the whole, whether through the mouth or by means of a submaxillary incision, undoubtedly is, but there is no evidence that the latter of these two methods is worse than the former. An incision through the cheek is only required when the growth extends down the side of the tongue in that direction.

The chief dangers attendant on removal are: *hemorrhage* from the lingual arteries, weakening the patient at the time and causing broncho-pneumonia later; *asphyxia*, from blood trickling into the lungs, acute œdema of the larynx, or falling back of the stump when the muscles that attach the tongue to the symphysis are divided; and especially *broncho-pneumonia*. This, which is by far the most frequent cause of death, is the result of blood, particles of food, or septic material from the foul and sloughing surface finding their way down the trachea. Sometimes there is gangrene of the lung; more frequently minute scattered points of consolidation, which do not give rise to any physical signs, but which can be diagnosed with almost as great certainty from the aspect of the patient. There may be no rise of temperature, no pain, and scarcely any cough; but the patient does not seem to rally; the face is dusky and pinched; the eyes surrounded by dark rings; the pulse quick and very small; and the respiration hurried and shallow. If it occurs it is practically fatal; but a very great deal may be done in the way of prevention by selecting suitable methods of operation and by careful after-treatment.

### 1. Removal without an External Incision.

This may be accomplished either with scissors (Whitehead's method) or with an écraseur (Morrant Baker's); the galvano-cautery is practically abandoned, owing to the extensive sloughing it causes.

(*a*) The scissors used by Whitehead are flat and straight, sharp up to the tips, which are square and blunted. The patient is placed under an anæsthetic in the position that will secure the best light; chloroform is usually preferred, given by means of a rubber ball syringe; but even more than the usual amount of caution is necessary, and unless a preliminary laryngotomy is performed, the administrator must watch with the greatest care that no blood trickles down into the trachea. The hands may be fastened to the side, but nothing should pass round the chest; and the body should not be fastened to the operating table, as it may be necessary at any moment to roll the patient over on to his side and syringe out the mouth in order to free it from blood.

As soon as the patient is anæsthetized, Coleman's or Mason's gag is placed between the teeth on the side opposite to the operator, and entrusted to an assistant, who attends to this and to the sponging. The lips can be drawn out of the way with retractors fastened to an elastic band, if it is considered necessary. A double silk ligature is then passed well through the substance of the tongue and given to a second assistant.

The operator begins by cutting the mucous membrane that extends from the

tongue to the alveolar process, keeping close to the bone. The anterior pillar of the fauces and the structures that attach the tongue to the jaw come next, the assistant meanwhile keeping the tongue well forward; then the muscles that form the base are cut across by a series of successive snips until the entire structure is separated on the plane of the inferior border of the lower jaw, and as far back as the safety of the epiglottis permits. The arteries are tied or twisted as they are divided, and a ligature passed through the remains of the glosso-epiglottic fold to draw the stump forward, in case of secondary hemorrhage.

Whitehead has never found any difficulty in securing the arteries. If there is any bleeding it can be controlled at once by passing the finger behind the root of the tongue, drawing it forward and pressing it toward the opposite side, as Heath recommends. Jacobson, with the view of avoiding it, merely cuts a deep groove through the mucous membrane on the side and dorsum, and then tears the soft muscular tissues with closed scissors until the artery and nerve are seen. Billroth ties the linguals first, but those who have followed out Whitehead's directions generally consider it unnecessary.

[The hemorrhage is certainly and easily controlled by passing an eyed transfixion needle through the skin and upward through the base of the tongue in the centre. A heavy ligature is now passed into the eye to the middle of the ligature; the needle is now withdrawn, bringing the ligature with it, which is cut to release the needle, which is then thrust through the same skin opening, and pushed into the mouth close by the side of the tongue opposite the ligature. One of the free ends is now threaded into the eye of the needle and withdrawn with it. The needle is now thrust through at the other side of the tongue and the remaining end threaded and withdrawn. The ends are now tied firmly, and both linguals are securely compressed.]

(*b*) When the écraseur is used the preliminary steps are the same, but two ligatures are passed through the tongue, one through each half, and the whole organ divided down the median septum. If the dorsum and tip are cut fairly deeply with a straight blunt-pointed bistoury, the two halves can be separated from each other with the forefinger without causing any material hemorrhage. The mucous membrane and the muscles passing from the jaw to the tongue are divided as before; and then, as soon as the two halves are thoroughly freed as far back as is considered advisable, a loop of stout whip-cord attached to an écraseur is passed over each. The section should be from the middle line outward, and the loop may be tightened fairly quickly at first, but as soon as any resistance is felt not more than one turn should be made in the minute. Very frequently the vessels, with, perhaps, the nerve, are dragged out in a long loop, when they can be easily secured and tied. If the whole of the structures that attach the tongue to the jaw have been divided, it is advisable to fasten the stump to the mucous membrane at the side of the mouth by means of sutures, for fear of its falling back.

It is very difficult to estimate the relative advantages of these methods, as they both require a considerable degree of skill, and operators are naturally inclined to that which they have practiced most. Morrant Baker's is the easier, and if the écraseur is only used slowly, is practically exempt from bleeding. On the other hand, it tends to make the stump convex, although this is concealed by the muscular contraction, and it is probable that the amount of bruising is greater. Certainly this was the case with the old chain écraseur. Contrasted with this, the scissors are sometimes followed by serious hemorrhage, but the operator can see the whole time what he is doing.

It is still an open question whether it is ever advisable to leave half the tongue. In most instances it bends round upon itself, owing to the contraction of the cicatrix, and only becomes an incumbrance; but occasionally it moulds itself into shape and assists both in speaking and swallowing.

Preliminary laryngotomy is advocated by many, and no doubt possesses great advantages, with slight, if any, additional risk. The fauces can be plugged so that no blood can possibly pass down; the administration of the anæsthetic is

easier; the mouth can be sponged freely if there is any bleeding; and the operator can proceed quietly and deliberately. As Jacobson points out, when scissors are used the amount of swelling and inflammation after the operation is so slight that there is no need to retain the cannula after the patient has rallied from the anæsthetic.

If any glands require removal, or if there is any infiltration in the floor of the mouth, a separate incision is advisable. The dissection in such cases must necessarily be very thorough if it is attempted.

### 2. Removal by Sub-maxillary Incision.

Of these, by far the best is that devised by Kocher, who performs it under the carbolic spray.

A preliminary tracheotomy is performed and an ordinary cannula inserted. Entry of blood is prevented by plugging the pharynx with a sponge soaked in carbolic acid. The incision runs along the anterior border of the sterno-mastoid from the ear nearly down to the middle of the muscle; from this it turns forward to the hyoid bone and along the anterior border of the digastric to the symphysis. A flap, containing skin, platysma, and fascia is reflected upward; the facial artery and vein tied; the lingual secured on the hyoglossus; and the sub-maxillary fossa completely cleared out, beginning from behind. All the cellular tissue is removed, together with the lymphatic glands, and the sub-maxillary and sub-lingual ones if they appear involved. The mylo-hyoid muscle is then separated, the mucous membrane divided, and the tongue drawn through the opening. If the whole thickness is removed the opposite lingual must be tied as well.

Before commencing the operation the mouth and the nasal cavities are thoroughly washed out with a solution of perchloride of mercury (1 in 2000); and after it is finished and the wound adjusted with sutures the surface of the stump and the pharynx behind it are covered over completely with a sponge soaked with carbolic acid. The dressings are changed twice a day, advantage being taken of the opportunity to pass an œsophageal tube and feed the patient; for the rest nutrient enemata are used. The operation is undoubtedly more extensive than the others, but it is believed that this is amply compensated for by the thoroughness with which the whole of the affected tissues is removed and the way in which the risk of septic inflammation and pulmonary complications is avoided. Kocher himself has been very successful as regards immediate mortality, but the operation does not seem to have been performed by other surgeons to any great extent.

*The after-treatment* of these cases requires even more than ordinary care. Every endeavor must be used to prevent putrefaction, which, owing to the temperature, moisture, and alkaline reaction, is very prone to follow; the patient's strength must be husbanded and maintained in every way; and precautions taken to prevent food or the discharge from the wound entering the lungs. With this in view, Kocher fills the entire cavity, from the edge of the wound back into the mouth and pharynx, with a sponge soaked in carbolic acid solution, shutting off the naso-pharyngeal cavity on the one hand and the larynx and pharynx on the other. The same object may, however, be achieved much more satisfactorily by means of a plan recommended by Barker. The whole wound is carefully cleansed, dried, and dusted with iodoform, and the two ends of the incision sutured. In the middle a piece of rubber tubing is adjusted, long enough to reach well down into the œsophagus; and all the space around is carefully packed with antiseptic wool. This can be left untouched for days, the patient being easily fed by means of a funnel as often as it may be required.

The ordinary practice, when the tongue is removed through the mouth, is either to wash the cavity out at frequent intervals with a dilute antiseptic, or to keep the surface of the wound as dry as possible by means of iodoform. Drainage is not very successful; a large tube may be passed through the floor of the mouth and fixed at the proper level, but it is of little use except to secure a thorough flow

ne in a line from the last molar tooth to the angle of the jaw. The finger is ed down to the bulging alveolar border to act as a guide; a curved bistoury sed so as to get in under the projection; and everything is divided down to bone.

## DISEASES OF THE TONSILS.

The tonsils lie between the pillars of the fauces covered with mucous membrane. Immediately outside is the superior constrictor of the pharynx, by which they are separated from the internal carotid and ascending pharyngeal arteries. Of these the former lies about half an inch behind and to the outer side; but, if it is thrown into curves, it may approach nearer. The latter appears insignificant; but, if wounded, the hemorrhage is scarcely less serious.

### INFLAMMATION.

(*a*) *Simple catarrhal or erythematous tonsillitis* sometimes occurs by itself, caused by fatigue or exposure to cold and wet; but much more often it is merely part, and the most insignificant part, of a general disorder, such as acute rheumatic fever, scarlatina, or septicæmia induced by the inhalation of foul air or sewer gas. The symptoms under these circumstances naturally present no sort of relation to the affection of the throat; there may be a rigor with very high temperature, as in scarlatina, or, on the other hand, the most profound depression, so as to suggest typhoid, as in poisoning by foul air; nor is there anything in the throat itself by which one condition can be diagnosed from the other. The surface is reddened; there is a slight amount of swelling involving the soft palate and fauces as well as the tonsil; the throat feels hot and dry; often there is a tickling or aching sensation in the ear; hearing is impaired; swallowing painful; and in severe cases there is tenderness on pressure behind the angles of the jaw. If the inflammation continues, the swelling becomes more and more prominent; white specks formed of sodden epithelium mixed with mucous and leptothrix filaments make their appearance in the depressions of the gland, and the follicles themselves become involved.

(*b*) *Follicular tonsillitis* may be acute from the beginning, when, for example, it results from catarrhal inflammation; but more frequently it is chronic and persistent, varied every now and then by acute or subacute attacks. The swelling involves the gland only; the mucous membrane around is but slightly affected; the surface is very uneven; all the crypts and depressions are filled with drops of muco-pus, and when these are detached or squeezed out funnel-shaped ulcers are left. The readiness with which inflammation breaks out and the persistent tendency to sore throat in those who suffer from this condition may be traced to the presence of these foul decomposing masses of epithelial debris, mucus, fragments of food, and leptothrix filaments. Each one acts as a source of infection for all the structures around, giving rise to an acute attack if, from any cause, there is the least hyperæmia or abrasion of the epithelium.

(*c*) *Hypertrophy of the Tonsils.*—Chronic enlargement of the tonsils is especially prone to occur in children, owing in part to the much greater activity of the lymphatic tissue in the early years of life, and in many cases is associated with a similar enlargement of the submaxillary glands. Practically it is the outcome of constant irritation, not sufficiently severe to cause either catarrhal or follicular inflammation, though these are often present as complications, and it affects especially the adenoid tissue. It is always bilateral, though very often one is considerably larger than the other.

If the tonsils are not inflamed, the surface is pale and smooth, or reticulated, from the widely stretched orifices of the crypts, which are much more shallow than natural; but often they are reddened, congested, and, if there is any inflammation of the follicles, dotted all over with yellowish-white patches, each of which

is surrounded by a brighter ring. There is little or no pain, unless the inflammation is acute, and no fever; but the voice is altered, assuming a nasal tone; respiration is interfered with, so that, particularly in rickety children, the chest falls in and becomes pigeon-breasted; hearing is impaired; the child is compelled to breathe through its mouth, and snores at night; the aspect becomes stupid and vacant; active exercise is rendered difficult; the blood is imperfectly aërated, and the general nutrition is seriously affected. Very often attacks of subacute or follicular tonsillitis occur as well, this condition apparently acting as a predisposing cause; and then the enlargement may become serious, and cause attacks of very alarming suffocating spasm at night.

(*d*) *Acute suppurative tonsillitis, or quinsy*, either commences in the tonsil itself, when, as a rule, there are a number of small abscesses side by side, and the symptoms are not of the most severe type, or in the cellular tissue around the gland. It appears to be due to the same causes as follicular and erythematous tonsillitis, acting with greater intensity, or affecting those who are broken down in health by over-work or other troubles. The periglandular form is practically confined to adult life, and has a marked tendency to return at distant intervals. Sometimes it affects the retro-pharyngeal tissue rather than the neighborhood of the tonsil itself, and it is distinguished by the way in which the tonsil is concealed from view; the arch of the palate is enormously swollen; the mucous membrane covering the anterior pillar of the fauces and the side of the tongue and mouth is a dusky red; the glands under the jaw are enlarged, and, in the worst cases, the loose cellular tissue that extends between the jaws and fills up the side of the neck and the floor of the mouth is involved as well, so that a huge swelling forms all over that side of the face, and the teeth cannot be separated from each other even to allow the tip of the tongue to protrude. Fortunately, this very severe form seldom affects the two sides at the same time, and suppuration rarely occurs in both. The onset is sudden, with a succession of severe chills, and the temperature may rise to 103° to 104° F. From the first there is unusual depression and anxiety; the pain is very severe, especially in the ear, but radiating all over the face; salivation is often profuse, and there is a constant secretion of viscid mucus at the back of the throat, causing great distress by exciting the reflex movements of deglutition. Breathing is difficult, swallowing almost impossible; the jaws are rigidly fixed, partly from the pain, partly owing to reflex muscular contraction; and, as pus begins to form, the throbbing becomes almost unbearable. In the slighter cases—those which affect the tonsil itself—a number of minute abscesses are usually present, and break one by one into the interior of the mouth; in the more severe ones, when there is acute periglandular inflammation, the pus may burst in the same direction at the end of the fifth or sixth day, giving great and immediate relief, or may work its way into the soft palate, or even sometimes down into the neck, before it can be evacuated. Even when the attack has been of short duration it always leaves a condition of serious debility.

**Treatment.**—The constitutional treatment of acute tonsillitis depends naturally upon the disorder with which it is associated. If none can be found, all that can be done is to meet the symptoms as they arise, giving quinine, salicylate of soda, or antipyrin when the temperature is high; and tonics, and especially iron, after the acute stage has subsided. Chronic hypertrophy, on the other hand, is nearly always associated with that peculiar susceptibility to inflammation which finds its highest development in what is known as scrofula, and must be met from the first with tonics, iron, cod-liver oil, good food, and sea air.

The local treatment must be guided by the severity of the attack. In the milder forms, which are frequently associated with a relaxed condition of the mucous membrane of the palate and uvula, astringent gargles (of alum, bichloride of mercury with decoction of cinchona, etc.) are sufficient. In more severe cases, in which there are numerous points of follicular inflammati · the accumulated debris may be removed by washing out the mouth with · water, and then the surface thoroughly brushed with nitrate of si · ʒj), glycerine, and

tannic acid, or glycerine and perchloride of iron. Much of the discomfort of this proceeding may be removed by using a solution of cocaine first; but even then in children it is often a matter of great difficulty. Sometimes a hand spray may be used, or creasote vapor inhaled from hot water, but these remedies are chiefly beneficial from a preventive point of view.

In chronic hypertrophy, when there is a mass projecting inward behind the anterior pillar of the fauces, nothing but excision is of any avail; and the same treatment should be recommended for those cases of follicular tonsillitis in which the patient is constantly suffering from recurrent attacks, occasioned by the retention of the decomposing discharge on the surface of the gland. Moreover, it seems probable that tonsils affected in this way are more prone to be attacked by diphtheria than others, the membrane beginning in the crypts and growing out from them over the epithelial surface; and this alone would be a most efficient reason.

As an alternative the application of the galvano-cautery is sometimes made use of. The throat must be thoroughly penciled with cocaine, and the burner applied while cold to the surface of the gland; the current is then turned on and a sufficient amount of tissue destroyed to make sure of a smooth, dense cicatrix when the wound heals. The pain is said to be slight, and to be relieved by sucking small fragments of ice for an hour or two afterward.

Acute phlegmonous inflammation requires more vigorous measures. An attempt may be made to cut the attack short at its onset by giving aconite (mj every half-hour) until there is a distinct effect upon the pulse; but it rarely succeeds. The bowels should be opened freely, while the patient can still swallow without much difficulty; ice placed around the neck, small fragments kept in the mouth; the patient induced to take as much liquid food as he can; and the surface of the swelling explored with the finger,

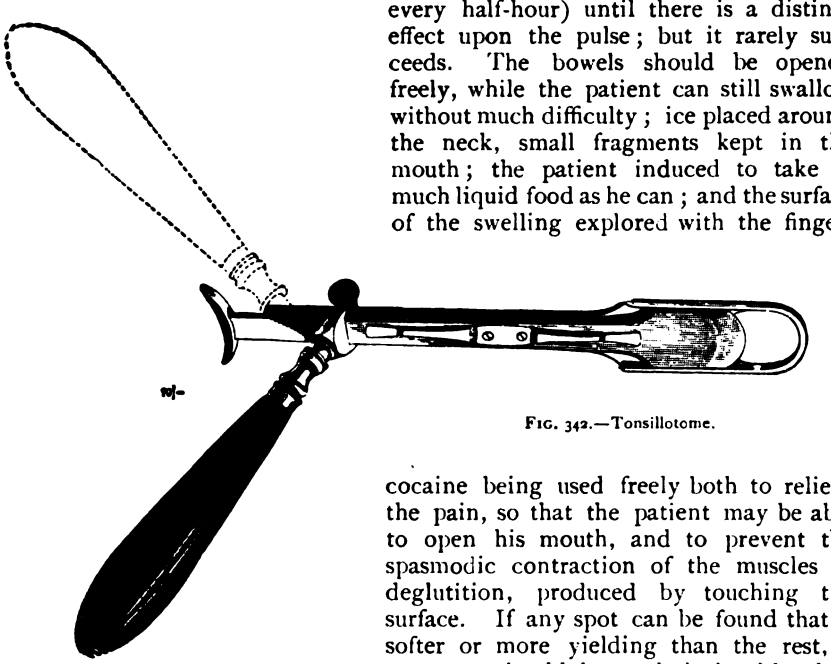

FIG. 342.—Tonsillotome.

cocaine being used freely both to relieve the pain, so that the patient may be able to open his mouth, and to prevent the spasmodic contraction of the muscles of deglutition, produced by touching the surface. If any spot can be found that is softer or more yielding than the rest, a puncture should be made in it with a bistoury, the blade of which is protected up to within an inch of the point by means of strapping wrapped around it. The tongue must be held down out of the way; the edge of the blade must point upward and inward, and the puncture be made just through the margin of the anterior pillar (which is forced prominently into the mouth), perfectly straight from before backward.

*Excision of the tonsil* may be performed with a bistoury, but it is much more satisfactory to employ a tonsillotome or guillotine. The simplest consists merely of a ring to slip over the projection, with, on its inner margin, a groove, carrying a blade. Both ring and blade are on the same handle, one gliding on the

other. A more complicated one carries a forked spear as well: this, by means of a spring, transfixes the growth and draws it slightly inward toward the middle line, making it secure, and ensuring sufficient being taken away. The assistant stands behind the patient, holding the head so that the light falls into the mouth, and pressing with his fingers just behind the angles of the jaws in order to steady the tonsils. An anæsthetic may be used, but even in children cocaine is sufficient. The operator stands in front, and it is of great advantage to him if he can use his two hands equally well. As much of the growth as projects beyond the pillar of the fauces should be removed, for although the cicatrix contracts to some slight degree, it really produces very little effect if the gland contains much soft adenoid tissue. When, owing to the frequency of follicular inflammation, it is denser and more fibrous, there is less probability of the growth recommencing. Both tonsils should, if they require it, be removed at the same sitting; the pain and inconvenience are not materially greater than when one is taken away, and the cure is effected in half the time.

Hemorrhage that does not stop on the application of ice is very rare. If capillary oozing continues to any serious extent, perchloride of iron or some other styptic must be employed. It has, however, been necessary to tie the common carotid.

In addition to these the tonsil is liable to be attacked by various forms of specific inflammation. *Diphtheria*, for example, not unfrequently begins upon the tonsil, starting from an apparently simple attack of follicular tonsillitis and spreading thence to the mucous membranes around. *Scarlatinal ulceration* may occur, and open up the internal carotid by the sloughing it causes. The same thing may happen in severe cases of blood-poisoning, such as result from the inhalation of sewer gas. *Syphilis* very often attacks them; there are very few cases of primary chancre, it is true, but a peculiar circular and sometimes punched-out ulcer is nearly invariable in the early secondary stage, and very extensive ulceration may occur at a later period, destroying the soft palate and the pillars of the fauces, and dragging the base of the tongue backward by the cicatrization it entails. *Tubercular disease* is more rare, and in the earlier stages is difficult of diagnosis; later, when the ulceration becomes general, it is scarcely possible to tell in what part the disease began.

Tonsillar calculi are not uncommon, caused in all probability by the gradual inspissation of the masses of muco-pus that are found buried in some of the follicles. In composition they resemble the tartar that collects upon the teeth, and they may reach the size of a pea or a small bean.

The only tumors that occur with any frequency are epithelioma and lympho-sarcoma, and even they are not common. The former is nearly always secondary, originating in the structures near and gradually extending into it. The latter is primary, but very little can be done for either. Sarcomatous growths have been shelled out after ligature of the carotid, with success as far as the immediate result of the operation was concerned; but very rapid recurrence took place in all.

## DISEASES OF THE SALIVARY GLANDS.

### Inflammation.

The parotid suffers the most often of the three; the sublingual the least.

Acute parotitis is well known from its occurrence in connection with mumps. It may, however, be caused in many other ways. In some epidemics of typhoid fever, for example, it is fairly common; in others it is very rare. In pyæmia it is often met with; not unfrequently, even when there is no suspicion of this, it follows operations on the abdominal viscera; and occasionally it is due to ptyalism, the passage of foreign bodies up the duct, syphilis, tubercle, and other dis-

In mumps suppuration is rare. The gland on one side suddenly becomes ense and swollen, assuming a characteristic shape, and causing very severe pain, specially when an attempt is made to open the mouth; and then when it is eginning to subside, the opposite one usually behaves in the same way. Some- imes the submaxillary gland is affected, together with or independently of the arotid. Metastatic inflammation of the testicle is not by any means uncommon, nd is of some importance, as it may end in atrophy. The ovaries and the eninges of the brain are also stated to be occasionally attacked, but this is much ore rare. In the other varieties of parotitis, suppuration is of frequent occur- nce and is often attended with high fever, owing to the tension of the fascia that rrounds the gland. The pus has been known to work its way into the ear and ischarge through the external auditory meatus; to descend under the deep fascia the neck; and even to track upward along the course of the nerves into the se of the skull and set up acute suppurative meningitis.

In front of the ear over the parotid there is a small group of lymphatic glands ich occasionally enlarge and become inflamed, and there are others in the in- ior as well; but the shape of the swelling is so different that there is very little k of their being mistaken.

The treatment presents nothing special. Suppuration is hard to detect until collection has attained a considerable size, owing to the dense fascia over the nd; but sometimes it is indicated by local œdema or by the presence of one ecially tender spot. A grooved needle should be used for exploration, and if pus is found the abscess should be opened after Hilton's method, as it is im- sible to say, under such conditions, in what direction the very important struc- s that lie in the gland are displaced.

## Salivary Calculi.

Calculi, composed of phosphate and carbonate of lime with magnesia and a portion of animal matter, are sometimes met with in the duct of the submax- ry gland, and much more rarely in that of the parotid. e usual size is about that of a date-stone; small ones are sed occasionally, and very large ones, the size of a eon's egg, have been recorded. In most cases they do give rise to symptoms of any kind unless the duct is cked: then the gland enlarges and becomes distended il it is able to overcome the resistance in front and eve itself for the time. Occasionally, however, they se considerable inflammation and lead to the formation a mass of dense inflammatory deposit extending through whole submaxillary region. The nature of the trouble sually detected at once by examination with one finger the mouth and another under the chin, or by passing a be down the duct. A free incision should be made ough the mucous membrane so as to release it without breaking it; if this urs the removal of all the fragments is sometimes very tedious.

FIG. 343.—Salivary Calculus, weighing 48 grains. Natural size.

## Tumors.

The parotid gland is occasionally the seat of a peculiar variety of new growth, tinguished from all others as a *parotid glandular tumor*. Sometimes a similar wth is met with in connection with the submaxillary. It consists of fibrous, cous, cartilaginous, and glandular tissue combined in varying proportions, and ms a firm, elastic mass of an irregularly lobulated shape. Usually it is enveloped a dense capsule and buried in the substance of the gland. Occasionally it is ached, lying on it, but in all probability developed in connection with it. It been suggested that the presence of cartilage may be accounted for by the

persistence of some portion of the branchial arches, the first in the case of the parotid, the second for the submaxillary.

FIG. 344.—Submaxillary Tumor.

Parotid tumors of this description are usually met with in young adults, and increase so slowly that little attention is paid to them. As age advances, however, they are liable to change their characters suddenly and develop into rapidly growing adeno-sarcomata; and sometimes they assume this character from the first, masses of vascular gland tissue developing in some parts, and soft sarcomatous growth in others.

When this occurs the tumor becomes painful and tender; the skin grows thin; the surface is reddened with dilated veins; and all the tissues near become involved. In a little while ulceration follows; the covering breaks down; gigantic fungating masses that bleed at the slightest touch protrude through the opening; hemorrhage sets in; and partly from this, partly from septic absorption and exhaustion, the result not unfrequently proves fatal within a few months.

Other tumors are seldom met with. Cysts may form either independently or in connection with other tumors, but they rarely attain any size. Mucous cysts are met with in the submaxillary, but probably not in the parotid. Lymphatic growths are occasionally found, and a few instances of fibromata and sarcomata are on record. It is questionable whether the cases of cancer were not really adeno-sarcomata, as the sarcomatous tissue is very unevenly distributed.

The only treatment is excision, but to be successful it must be done while the growth is small. The incision should lie over the posterior border of the gland; if necessary a second may run forward from this at right angles to it. If the capsule is opened freely the tumor can sometimes be shelled out; but if it has deep connections, running, for example, down to the styloid process or behind the ramus of the jaw, or if the facial nerve, instead of lying beneath it, runs through it, the operation becomes exceedingly difficult. It is advisable if possible to keep inside the capsule; and if the facial nerve runs into the tumor an attempt must be made to dissect out the chief branches, but the result is rarely satisfactory. Facial paralysis invariably results if any traction is put upon the nerve in separating the tumor from it; but, fortunately, unless the fibres are too much bruised, or are cut away to such an extent that the ends cannot be brought together, the muscles usually regain sufficient power to prevent conspicuous deformity. In cases of accidental division the ends should of course be sutured at once.

Excision of the parotid has been performed, but never with sufficient success to justify repetition.

# CHAPTER XIII.

## *SURGICAL DISEASES OF THE EAR AND LARYNX.*

By T. Mark Hovell.

## SECTION I.—DISEASES OF THE EAR.

### Examination of the Ear.

To ensure this being carried out thoroughly, it is well to adopt a definite order for employing the various tests to the patient's hearing and for inspecting the ear and other parts. This is best done by grouping the methods of examination which require light and those for which it is unnecessary.

Any *watch* may be used as a test for hearing, provided the distance has been ascertained at which its tick can be heard by a normal ear. This distance is recorded as a denominator, and the patient's hearing power is the numerator. Thus, using a watch that can be heard at six feet to test a patient who hears at thirty-six inches with the right ear and twenty inches with the left, the result would be recorded: right, $\frac{36}{72}$; left, $\frac{20}{72}$.

A vibrating *tuning-fork*, when placed on the vertex of the skull in the middle line, should be heard equally in both ears, and when one meatus is closed with a finger the sound should be louder on that side, on account of the vibrations being confined and consequently to some extent thrown back upon the labyrinth. If, therefore, a patient hears a tuning-fork, applied as above mentioned, louder in the ear in which the hearing is impaired, it may be inferred that the conducting apparatus is at fault, and if it is not heard as well as in the other ear, that the labyrinth or auditory nerve is affected.

Malingering may be detected sometimes by using the tuning-fork in this way, the impostor thinking that he ought not to hear so well with the ear closed.

The extent to which the labyrinth or auditory nerve is impaired may be roughly gauged by placing the tuning-fork over the mastoid process of the affected side and noting the number of seconds that the vibrations can be heard by the surgeon when the fork is applied to his own head after the patient has ceased to hear them.

*The auscultation tube* is a piece of rubber tubing about thirty inches long, having at each end a hollow piece of ivory or vulcanite to fit the meatus. To distinguish the end used for patients, one ear-piece may be made of ivory, the other of vulcanite.

By placing one end in the patient's ear and the other in one's own the condition of the Eustachian tube can be ascertained whilst the tympanum is being inflated, by Valsalva's or Politzer's method or by means of a Eustachian catheter. Thus, if there is moist mucus in the tube or tympanum a bubbling sound is heard, or whistling if the calibre of the tube is narrowed. In cases in which the membrana tympani is perforated the injected air can be felt by the surgeon striking against his own membrane.

*Valsalva's method* of inflating the tympanum consists in expiring forcibly through the nose whilst the mouth is closed and the nostrils are compressed by a finger and thumb. In a healthy ear the entrance of air is accompanied by a feeling of fullness and slight cracking sound.

*Politzer's method* consists in holding a small quantity of water in the mouth, and then, whilst it is being swallowed, forcing air from an India rubber bag through one nostril while the other is compressed with a finger or thumb to prevent the air

escaping. The sensation produced in the ear is similar to that caused by Valsalva's inflation, but more marked.

The late Dr. Peter Allen used to force air into both nostrils simultaneously by blocking their orifices with an India-rubber pad through which passed two pieces of tubing, one of which enters each nostril.

Instead of swallowing water, the naso-pharynx may be shut off by the patient whistling or uttering a guttural sound, such as "huck." In children it is unnecessary, as the Eustachian tube is more patent.

*A Eustachian catheter* should not be more than four and one-half inches long, and it is most convenient to use one with a diameter of small size. Whilst introducing it the surgeon should stand at the patient's right side with the catheter held lightly between the thumb and index finger of his right hand, the beak or curved end pointing downward, and allow it to slip through the nostril until it touches the posterior wall of the naso-pharnyx. It should then be withdrawn half an inch and the beak turned outward and sometimes slightly upward, when it will be found to be in the orifice of the Eustachian tube.

FIG. 345.—Allen's Air-pad.

As the dimensions of the nostrils vary very much, owing to deviations of the septum, cartilaginous and bony spurs, and other abnormal conditions, there is no fixed rule for the position of the catheter during its passage. It often passes best if the beak is directed horizontally outward beneath the inferior turbinated bone as soon as it is well within the nostril, turning it down again a little as it goes through the choana. A catheter should always be passed with the greatest gentleness, and, in many instances it is best to allow it to find its own way. Should it be impos-

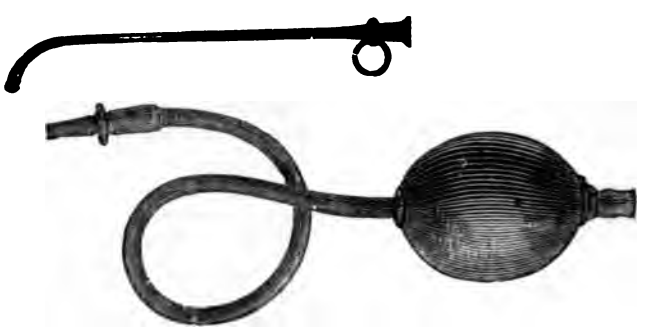

FIG. 346.—Air-bag with Nozzle to fit a Catheter, suitable also for Politzer's Inflation, with a Teat slipped over it.

sible to reach the tube through one nostril, the curve of the instrument must be reversed, and an attempt made to do so through the other. If the catheter is drawn backward by muscular contraction, when the beak is turned outward in the naso-pharynx, it is an indication that it is behind the posterior lip of the Eustachian orifice. A special catheter with a distinguishing mark should be kept for such cases. If a nostril is extremely sensitive, it may be sponged with a four per cent solution of cocaine.

As soon as the catheter is in positio e and ring fingers of the left hand should be placed one on each side 's nose, the palm of the hand

being downward and forward, and the outer end of the instrument grasped between the thumb and index finger. By this means the catheter is firmly held, and the hand at the same time well supported against the patient's face. The nozzle of the air-bag should now be introduced, and the thumb and index finger of the left hand slipped forward to hold it in place. Air is then forced into the tympanum by compressing the air-bag. Many aurists prefer a modification of Politzer's bag, having a piece of tubing between the air reservoir and the nozzle, which prevents the movement of the bag being communicated to the catheter.

For *examining the membrana tympani*, two kinds of speculum are used, one consisting simply of a funnel of metal or vulcanite, the other (Brunton's) of a metal funnel with a lens at the opposite end and an aperture at the side for the admission of light. For using the former daylight is sufficient, but for the latter artificial illumination is necessary. The focus for a Brunton's speculum should be three-quarters of an inch from the end when the centre of the cap containing the lens is level with the larger extremity of the speculum.

FIG. 347.—Brunton's Auriscope.

Before the speculum is introduced, any abnormal condition of the outer part of the ear should be noted, and the auricle raised upward and backward in order to straighten the canal.

A healthy membrane is of a bluish-gray color, and is placed obliquely across the canal, its upper and posterior part being more external than the lower and anterior. Passing downward and backward and a little inward, nearer the anterior than the posterior edge of the membrane, is a whitish ridge, the handle of the malleus, and passing forward and downward from its lower extremity, which is slightly enlarged, and situated just below the centre of the membrane, is a triangular glistening surface called the *cone of light*, having its base toward the periphery. At the upper part of the handle of the malleus is a white projection, the short process of the malleus, and stretching backward and forward from the short process to the edge of the membrane are two slight ridges, the anterior and the posterior folds, the latter being the more clearly defined. Above these folds the membrana propria is absent, the part being called Schrapell's membrane. Not infrequently a whitish line (showing the position of the long process of the incus) is seen behind, internal and parallel to the upper part of the handle of the malleus. Occasionally the outer part of the stapes can be distinguished.

After the position, color, degree of transparency, and any abnormal condition of the membrane that may exist, have been carefully noted, the nares, larynx, and naso-pharynx should be examined.

## DISEASES OF THE EXTERNAL EAR.

*Anomalous formations of the auricle* are sometimes found ; they are generally associated with defects in the meatus or the deeper parts of the ear.

*Accumulation of wax* is due either to increased activity of the glands, or to obstacles interfering with the escape of their secretion. The former condition is often associated with disorders of the external and middle ear, the latter may be produced by exostoses, or foreign bodies, or by the cerumen being pushed into the meatus during attempts to cleanse it.

**The symptoms** vary according to the size and position of the plug. They are, generally, deafness, often coming on or increasing suddenly, tinnitus, giddi-

ness, and cough; usually there is no pain. The glistening surface of the drum has been mistaken for the membrana tympana.

**Treatment.**—Syringing with warm water is generally sufficient to remove the meatus if the stream is directed against its floor, but should the plug be impacted near the orifice it may be gently moved with a spud. If the syringing causes pain, the wax may be softened with the following drops:—

| | Gtt. |
|---|---|
| Sodæ bicarb., | . . . . . |
| Glycerini, | . . . . . |
| Aq. dest., ad. | . . . . . |

If the ear is tender a few drops of liq. opii sedativus may be added. After the wax has been removed the meatus should be dried with absorbent cotton, and sometimes a piece kept in the meatus for some hours,

*Othæmatoma, or blood-tumor of the auricle* (*hæmatoma auris*), may arise spontaneously or be due to injury; the former is much more common, especially among insane patients, and more often in men than in woman. It appears as a swelling on the outer surface of the auricle, produced by the effusion of blood beneath the perichondrium. The size, outline, and tenseness of the tumor depend upon the amount; its color, on the depth.

**Treatment.**—If the tumor is small and not very tense, it may gradually subside, or the fluid may be evacuated and pressure applied. Traumatic cases are sometimes attended by great disfigurement.

*Fungi in the external auditory meatus* are usually found where there has previously been disease of the parts, producing an accumulation of epidermis. There is usually tinnitus, pain, and impairment of hearing. On examining the meatus, the fungus is seen on the walls of the canal and often also on the tympanic membrane.

**Treatment.**—The ear should be syringed several times a day with a weak solution of perchloride of mercury (1 in 1000), or hyposulphite of soda (gr. x to ℥i). And then a few drops of warm alcohol should be put into the ear. This should be continued for several days.

*Circumscribed or furuncular inflammation of the external meatus* is usually found in the cartilaginous portion, and is often associated with derangement of health; it may be due, however, to local irritation.

**Symptoms.**—If the deeper part is affected fever and even delirium may occur, especially in children. The pain often radiates over the side of the head, and is increased by movement of the jaw and by making pressure over the tragus; it generally increases toward night, and continues with but slight diminution until the abscess bursts or is opened. Deafness, when present, is mainly due to the obstruction. Tinnitus may be present. There is often no congestion of the meatus, but one or more extremely tender swellings inside. Recurrence is common, especially in weakly subjects.

**Treatment.**—Leeches may be applied to the tragus; plugs of gelatine containing 1/6 grain (.01) of extract of opium inserted into the meatus; and an incision made into the swollen tissue. After the incision the parts should be washed with carbolized glycerine or solution of boric acid. Hot poultices should be applied to the auricle. Opium should be given internally to relieve pain, and attention paid to the general health.

*Exostoses* are generally multiple and sessile, and they vary in size from slight elevations to large rounded projections. They are often associated with chronic catarrh of the middle ear, and are also said to be caused by gout, syphilis, and sea bathing. They grow slowly and should not be interfered with unless they close the meatus. They can be removed with a dental drill. Pedunculated growths are sometimes found in cases of chronic suppuration; they grow rapidly and are, as a rule, easily removed with a pair of forceps.

*Foreign Bodies in the External Auditory Meatus.*—When a patient thinks he have a foreign body in the ear, the first step is to ascertain that the statement

may be made at longer intervals. In
warmed, may be used several times a da
opii 3ij, water to 3j. *Granulations* tha
should be scraped away with a sharp spo
of chromic acid, according to their posi
rounding structures. *Polypi* attached tc
with a snare, unless very small. The w
their root and the loop then tightened u
be dragged out; if the wire is tightene
tion of it left behind. The polypus ma
out. Before removal a 10 per cent. or
dropped into the meatus, and afterward
tion of chromic acid, warmed alcohol l

*Inflammation of the mastoid cells* m
disease from the tympanum. The symp
over the mastoid process, accompanied
osteum is affected, the tissues behind the
out from the head. If pus has formed, t

**Treatment.**—In the early stages,
should be applied over the seat of pain,
these measures fail to give relief, an inci
process and the periosteum divided. If
ment, the mastoid cells must be opened.
of an inch in diameter is large enough
regulate its penetration. The opening s
tical line drawn a quarter of an inch be
horizontally on a level with its upper bc
and a little upward. Relief may follow
in the mastoid antrum. The thickness
it is generally about a fifth of an inch in
on to the mastoid process, pus is found
bone, it is best to enlarge it instead of r
toid cells have been reached, they shoul
lotion.



*Caries and necrosis* may attack the

### Syphilitic Affections of the Ear.

...and ulcers are sometimes found in the external auditory meatus. ...of the middle ear, probably due to the periostitis, may occur, and ...catarrh is already present, it runs a much more rapid course than in ..., frequently leaving the patient extremely deaf, in consequence of ...ear having become implicated. At puberty, subjects of inherited ...liable to lose their hearing, in consequence, it is believed, of the ...ing the terminal portion of the auditory nerve.

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## SECTION II.—DISEASES OF THE LARYNX.

### Examination of the Larynx.

...struments used for examining the larynx are so well known that it is ...to describe them. Before purchasing a frontal mirror, it is well to try ...spectacle frame or an elastic band round the head is the more comfort... ...for constant use a strong preference is sometimes felt for one or the ...aperture in the mirror should be elliptical in shape and not more than ...ch in the longest diameter; it should be made in the glass as well as in ...ck. A special set of faucial mirrors should be kept for syphilitic cases, ...guished from those in general use by their handles being of a different ...e mirrors which have been introduced with an electric lamp attached ...ys and useless for continuous work.

...mine *the larynx* the faucial mirror should be warmed until the dimness ...es as soon as heat is applied has almost passed off. If held over the ...it has quite disappeared, the mirror is generally too hot. The tongue ...be protruded and firmly but gently held with a napkin between the ...forefinger of the left hand. Care should be taken to keep the under ...the tongue from touching the incisor teeth: this will not occur if the ...is held horizontally and the left hand kept well raised.

...the tongue is held, the rays of light reflected from the frontal mirror ...ssed on the base of the uvula and the faucial mirror placed firmly but ...inst the same place, gently raising it so as to lift the soft palate. If the ...uvula is reflected in the mirror, this must be lowered a little. Patients ...directed not to hold their breath whilst their throat is being examined. ...ch irritability of the pharynx exists, a 4 per cent. to 10 per cent. solution ...should be sprayed or painted over the soft palate and posterior wall. ...lly the larynx may be examined without the tongue being protruded: this ...sometimes useful when the pharynx is very irritable and a solution of ...not at hand.

...lation.—Apparatus for the inhalation of medicated steam should be con... ...that the air may enter near the bottom of the vessel and bubble slowly ...the whole depth of the fluid. Patients should be directed to breathe ...six or seven times a minute only, not to expire into the inhaler, and to re... ...ons for twenty minutes or half an hour afterward, to avoid catching cold. ...lation should be used at a temperature between 140° F. and 150° F.

...ative inhalations may be composed of: tæ. benzoini co., ʒj: acid. benzo... ...ij; kaolin, gr. xij, and tæ. tolu, ♏xviii: lupulin, gr. xxx; or sodæ ...gr. xx, and succus conii, ʒij: a pint of water at 140° F. being used in ...e: stimulating ones of two or three minims of oil of Scotch pine, oil of ...or of creasote, with a few grains of light carbonate of magnesia, used in ...

*Insufflation.*—The patient should be directed to hold his tongue we with a handkerchief, using his right hand to enable the operator to application by the aid of a mirror held in his left. If a powder i end of the insufflator is bent at a right angle to the stem, and the desce is not more than half an inch in length. Blowing down the tube with ensures a more accurate application than using a ball syringe. It is co have the rubber tube which connects the mouth-piece with the instrume than fifteen inches long.

The best spray producers are worked by compressed air, the high t suring the even distribution and fine division of the fluid. There is no same tendency to cause coughing. Hand sprays should be fitted with the anterior being used as a reservoir. By compressing the tubing bet and the bottle until the moment the spray is used, the tension is incre the fluid more finely atomized.

Brushes are necessary where a particular portion of the larynx has to be with the solution; they should be made so that they readily come to directly they are wetted. If too large, difficulty will be experienced in in them into the larynx. On the Continent and in America solutions are a means of a piece of cotton-wool twisted round a piece of bent wire, in brush.

### Inflammation of the Larynx.

*Acute laryngitis* (*catarrhal laryngitis*) is most frequently met with in whose vital powers have become depressed by anxiety, excessive mental prolonged physical exertion, sedentary occupation or living in ill-ventilate The commonest exciting cause is sudden or prolonged exposure to a d atmosphere or to a draught of cold air impinging upon the neck or an e ally when the skin is perspiring freely, but an attack may be caused by th tion of dust, fumes from chemical compounds, or a vitiated atmosphe charged with tobacco smoke. It is sometimes due to the straining continued shouting, to paroxysms of coughing or speaking for a length o an improperly pitched tone of voice, or to the entrance of a foreign body larynx. In many cases the inflammation extends from the nares or phar occasionally from the trachea. Errors in diet, and particularly the sumption of hot alcoholic drinks, may originate and keep up catarrhal l especially in its subacute form.

The **symptoms** vary according to the stage and degree of the att first there is diminution in the amount of secretion, and this gives rise to tion of tickling or dryness which frequently produces cough; later on the of mucus increases, but it rarely becomes excessive. On making a laryn examination, the whole of the larynx is seen to be extremely congested many cases an elliptical aperture between the cords is visible during ph produced by imperfect approximation. Erosions on the upper surface border of one or both vocal cords are frequently met with, the places de epithelium generally being oval in outline and lighter in color than rounding tissues. True ulceration is never met with in laryngitis unco with constitutional disease. Occasionally after a violent fit of coughing seen on the surface of the mucous membrane or extravasated into the sub tissue. This condition has been termed laryngitis hæmorrhagica, but i deserves a separate name, as it is only a chance occurrence. The voice merely hoarse or almost absent, its alteration in tone being dependent mo the paretic condition of the vocal cords or mechanical interference wi movements, than the congestion or swollen condition of the mucous me of the larynx itself. Adults, as a rule, recover from an attack of acute la in a few days if treated from the commencement, but, if neglected, the may remain in the subacute form for some time and eventually pass i chronic stage. In children acute laryngitis is a much more serious ma

the interference with respiration, due partly to the smaller size of the

tment.—The patient should be kept in a warm room on light diet, g stimulants. Sedative inhalations should be given every three or four ecase is acute, or at longer intervals when less severe. A saline febrifuge administered, to which may be added a small quantity of opium to cough; the form which I prefer is a mixture of citrate of potash with and tincture of camphor. One or two drachms of the ammoniated quinine, taken in water every three or four hours, is sometimes useful. t, especially a small dose of calomel, is often beneficial at the com- t. In children the air should be warmed and moistened by making a he bed and allowing the steam from a bronchitis kettle or Lee's steam haler to enter it.

### CHRONIC LARYNGITIS.

often follows an acute or subacute attack, especially if it has been ; but any of the conditions that excite acute inflammation may induce in it when it has once commenced. A congested condition of the mucous is very common in boys at puberty, owing to the hyperæmia that accom- sudden development of this organ (causing what is popularly known as voice"); and a similar affection is present in most cases of old-standing d in chronic bronchitis. Men suffer more frequently than women, ll probability to more frequent exposure; children of both sexes are rely exempt.

bjective symptoms in many cases are not marked, especially when there sity to make frequent use of the voice. Slight irritation and dryness of with a tickling cough, are all that a patient usually experiences; but ally become greatly increased, if the voice is used for any length of a pricking or burning sensation in the throat may ensue, accompanied g of obstruction, which the patient endeavors to relieve by constantly the throat."

bjective symptoms are hoarseness, increased secretion, and certain defi- s in the tissues of the parts. A marked feature of this disease is that nes the hoarseness is most noticeable when the patient begins to use the having been silent for some time, the natural tone, however, being a few minutes. This phenomenon is probably due to the increase in upply and nerve force to the part consequent upon the vocal effort. If t continues to use his voice a feeling of fatigue is soon experienced ness quickly supervenes. When the affection is less recent, the voice tinually hoarse or even lost. Sometimes it is natural unless attempts are nt it, such as by preaching, singing, etc. In chronic laryngitis there ncreased secretion of mucus, which may be seen adhering to the interior ix and especially to the vocal cords, gluing the latter together. As a ick, grayish in color, and at times, when expectorated, streaked with f chronic bronchitis exists the secretion is more profuse and less tena- racter. The larynx is generally more or less congested, but at times mia is limited to a particular part of the cavity, a vocal cord or a ce being not infrequently the only seat of marked increased vascularity. larged blood-vessels may be seen running parallel with the length of ng its centre or attached border, giving the part a streaky appearance. s membrane is generally swollen, and in old-standing cases the sub- se also is considerably involved. This thickening produces to some hoarseness which accompanies the affection, but this symptom is at ly aggravated by the swollen interarytenoid fold interfering with the pproximation of the vocal cords. As a result of chronic laryngitis, nascences are not infrequently met with, and the non-malignant forms l growth owe their origin to long-standing hyperæmia.

Chronic inflammation of the larynx is often attended with changes in the tissues themselves, the subepithelial portion of the mucosa being converted into lymphoid tissue. In aggravated cases of chronic laryngitis one or both cords may be found persistently congested and the surface granular in appearance, or a portion of a cord (generally the anterior) may be seen to be markedly increased in size, in consequence of the hypertrophied condition of the connective tissue of the part. Another feature noticeable at times in this affection is a paretic condition of some of the intrinsic laryngeal muscles, producing loss of power, even if not actual loss of movement, in one or both cords, usually, however, only in one. If but one cord is affected, on phonation the opposite one crosses the mesial line to approximate with it, provided the mucous membrane is not too swollen to allow of such movement. Erosions of shallow ulcerations, which extend no deeper than the epithelial layer, are not infrequently seen in this disease, a frequent seat being the posterior wall of the larynx and the cartilaginous portion of the vocal cords. In some cases of chronic laryngitis, especially those occurring in strumous persons, the subglottic region becomes especially involved, giving rise to hoarseness, which is often quickly followed by complete loss of voice. Thickening of the tissues, especially at the outer surface of the vocal cords, is the condition which specially attracts attention when a laryngoscopic examination is made, the tumefaction often presenting the appearance of a second vocal cord immediately below the true one.

The surface of the swelling is generally smooth and whitish-gray in color, but occasionally it is ulcerated and touched with red.

In some cases the disease appears to originate in the cartilage or perichondrium, the structures below the anterior commissure of the vocal cords, or those on the inner surface of the sides of the cricoid cartilage, being most frequently affected—both situations in which the mucous membrane is in direct contact with the perichondrium. In consequence of the swelling which exists in these cases, dyspnœa may occur to an extent which necessitates tracheotomy. In all cases of long-standing chronic laryngitis the individual and family history of the patient should be carefully inquired into and the lungs examined from time to time.

With efficient local treatment a favorable prognosis may be given, provided that (1) the disease is of comparatively recent date; (2) is not accompanied by any marked tissue changes; (3) the exciting cause has been removed.

**Treatment.**—Unless remedies are persistently employed, the affection will remain stationary, even if it does not progress; or the symptoms may disappear for a time and then recur with the slightest irritation. Chronic laryngitis affecting the subglottic region is much more intractable than the ordinary variety, on account of the difficulty of applying remedies.

In cases of chronic laryngitis, which are not of long standing and which present no marked tissue changes, stimulating steam inhalations—pine oil or creasote, for example—are of very great service, but it is necessary to expire the vapor through the nostrils as well as draw it into the larynx, because the pharynx and naso-pharynx are usually also involved. The inhalation of fumes of chloride of ammonium is useful in checking excessive secretion. It is essential that it should be neutral, as an excess of either hydrochloric acid or ammonia causes irritation.

In more advanced cases astringents may be applied to the larynx with a brush, or, better still, in the form of spray. A solution of chloride of zinc (15 to 30 grains to an ounce of water), or perchloride of iron (30 to 120 grains to an ounce of water), may be used with a brush. Should spasm of the glottis result from the application, the patient should be made to speak and repeat a word until the spasm subsides. Solutions for application in the form of a spray should be weaker:—

| | |
|---|---|
| Chloride of zinc, | 2 to 10 gr. to ℥j |
| Sulphate of zinc, | 2 to 10 gr. to ℥j |
| Perchloride of iron, | ¼ to 2 gr. to ℥j |
| Alum, | 1 to 10 gr. to ℥j |

here there is much inspissated mucus adhering to the interior of the larynx, it is ll to spray the cavity with a weak alkaline solution to soften the tenacious film d allow it to be got rid of before any other application is made. Should much ickening exist the stronger astringents must be used, and if these fail to reduce e hypertrophied tissue, it may be necessary to destroy it by means of a galvano-stery. Where there is long-standing hyperæmia with diminished secretion, car-lic acid and glycerine (ʒss–ʒj of pure carbolic acid to ℥j of glycerine) may be plied. Turpentine is sometimes useful if the secretion is excessive. If paresis the laryngeal muscles has supervened, electricity must be employed to the terior of the larynx, a constant or combined current being the most efficacious. long as inflammation exists in the larynx it is obvious that the voice should be ed as little as possible. When congestion or relaxation of the pharynx or nares present it must be treated, and any local source of irritation removed. Atten-n should be paid to the general health, and tonics prescribed, or change of air commended, as may be required.

*Perichondritis of the larynx* usually occurs as a sequel to some other disease, ch as phthisis, cancer, syphilis, typhoid fever, or to an injury, but it may be imary. It is generally found in adults, and is more common amongst males an females. A dull aching pain in the larynx is often experienced, and there generally more or less congestion, with swelling of the tissues over the affected rt. Ulceration may occur, and if an abscess has formed and burst internally, ns may be visible.

Immobility of one or both vocal cords may result from the swollen condition f the tissues around the arytenoid cartilages, or from implication of the recurrent ryngeal nerve. Œdema is generally present in secondary perichondritis. The ricoid and arytenoid cartilages are most frequently affected, the inflammation sually beginning in the perichondrium. Beyond soothing inhalations and scari-ication (if there is much œdema) little can be done locally to arrest the disease. Leeches are occasionally useful in the early stages, and sometimes an abscess may e detected and opened with a laryngeal lancet before it has burst. Trache-otomy is often required. Dilatation with hollow bougies has been recommended o counteract the stenosis which often follows this affection, but the results of this nethod of treatment are unsatisfactory.

*Laryngeal phthisis* is usually associated with pulmonary disease, but it may be ell marked in the larynx without any evidence of it in the chest, and it is said o have proved fatal without any tubercle having been found in the lungs. The redisposing causes are the same as those of pulmonary phthisis. Males are more equently affected than females, and most cases occur between the ages of twenty nd thirty. Excessive use of the voice undoubtedly hastens the development of e disease.

**Symptoms.**—In the early stages there is nothing characteristic in the ppearance of the larynx beyond that of chronic laryngitis, but as the disease dvances, the mucous membrane becomes thickened and infiltrated by the tuber-lar deposit, commencing over the arytenoid cartilages or in the interarytenoid old, and spreading as a pyriform swelling toward the epiglottis. It may begin, however, in the epiglottis or other parts. By degrees the other parts of the larynx become affected, until most if not all of the laryngeal tissues are involved. It is unusual to find extensive infiltration confined to one side. In the majority of ses pallor of the mucous membrane is a distinguishing feature of this disease, but phthisical subjects are prone to catarrhal affections, congestion and erosions of e mucous membrane are often present at the same time.

Tubercular ulcers have a marked tendency to coalesce, thereby giving the rface attached a worm-eaten appearance. Individual ones are shallow and of nall size, their floor having a granular appearance. Not infrequently the epi-ottis and the neighboring structures are extensively destroyed. Paresis of one both vocal cords may be present, due either to tubercular infiltration of the ryngeal muscles, or to the interference with their movements that arises from

the swelling of the laryngeal tissues. The general debility, however, the loss of tone in all the muscles, and the extreme bodily weakness induced by this disease are not without influence. The right vocal cord is more frequently affected than the left, in consequence of the recurrent laryngeal nerve on that side being pressed upon by pleuritic exudation, or as a result of consolidation of the apex of the lung. Pressure from enlarged bronchial glands sometimes acts in the same way. Necrosis and caries of the cartilages may occur; wart-like excrescences are sometimes seen projecting into the interior, and in cases not far advanced thickening of the interarytenoid fold with irregular tooth-like projections may be seen similar in appearance to those found in chronic laryngitis.

Hoarseness is often present in the early stages of the disease, but this largely depends upon the condition of the larynx. At times the voice is almost lost in consequence of the imperfect action of the vocal cords, or the want of sufficient expiratory power in the lungs. Cough rarely fails, but it is not accompanied with much expectoration when the laryngeal changes are slight, unless the lungs are decidedly involved or catarrh is present.

In the earlier stages a certain degree of pain on swallowing may be experienced; later, as the swelling extends, there may be as well a feeling of obstruction to the passage of food. Still later, especially when the epiglottis and ventricular bands are involved, the greatest discomfort is produced by liquids passing into the larynx. Unless perichondritis is present there is no pain in the larynx except during deglutition. In giving a prognosis the most important points are the condition of the epiglottis and arytenoid cartilages and the extent to which ulceration has advanced.

**Treatment.**—In addition to the usual constitutional measures, local treatment is of service in modifying the progress of the disease and adding to the comfort of the patient. Lozenges containing a small quantity of opium or morphia are useful for relieving cough. During attacks of catarrh, sedative inhalations give relief, and stimulating inhalations may be used when the tissues are anæmic and not much infiltrated. Lactic acid appears to arrest the spread of the affection; it may be applied with a brush, or injected directly into the tissues; a 20 per cent. solution being used at the commencement, and the strength increased to 40 or 60 per cent.

Astringents applied either with a brush or by means of a spray rarely do good, and frequently cause irritation. Considerable relief, however, may be obtained by the application of a 20 per cent. solution of menthol in olive oil. It occasionally happens that the infiltration of the tissues of the larynx becomes so great as to require tracheotomy, but the operation ought never to be done merely with the object of giving rest to the larynx.

The pain in swallowing may be somewhat relieved by the application of cocaine and by thickening the liquid nourishment and directing the patient to swallow it in gulps. Patients have been recommended to lie in the prone position across a bed and to suck up the nourishment through a tube.

*Lupus* is usually associated with evidence of the disease on the skin or the soft palate, but occasionally it is confined to the throat. It is more often found in females than in males, and amongst the lower classes of society. Its characteristic features are hypertrophic changes followed by slowly spreading ulceration, the surface of which has a worm-eaten appearance; sometimes the hypertrophied tissues are nodulated. The mucous membrane is congested less than in syphilis, but more than in phthisis, and its sensibility is usually diminished. The epiglottis is frequently attacked, and may be completely destroyed.

*Syphilitic laryngitis* is not an invariable accompaniment of the manifestations of the disease elsewhere, and often does not come on until some time after the pharyngeal symptoms have disappeared. Its most constant feature is congestion, which is usually difficult to remove. Mucous patches and condylomata are present at times, and have usually an oval or sometimes roundish outline; they are less persistent than in the pharynx and not always symmetrical, sometimes occur-

ing on the ventricular bands and arytenoid cartilages or edges of the epiglottis. Erosions of the mucous membrane and superficial ulceration are not uncommon, and their tendency to recur is a marked feature of the affection. The degree of hoarseness is dependent upon the extent and position of the laryngeal changes, and although in most cases a natural tone of voice for conversation is eventually regained, the singing voice frequently remains impaired.

*Tertiary syphilis* of the larynx is usually marked by deep ulceration, but cases occur in which persistent congestion, accompanied by more or less thickening, with or without superficial ulceration, is the prominent feature. These changes sometimes make their appearance many years after the initial lesion, impairment of health generally being the determining cause.

The epiglottis is frequently the seat of ulceration, its lateral or upper border being usually first attacked. In the later stages of syphilitic disease œdema is often present. When false excrescences occur, they are generally situated on the interarytenoid fold or anterior surface of the posterior wall of the larynx. Gummata are occasionally found. The cicatrix produced by the ulceration may form a web between the vocal cords, and frequently causes stenosis, rendering tracheotomy necessary. The thickening around the cricoarytenoid joint not unfrequently leads to permanent stiffening of the articulation.

In many cases only general treatment is required. When there is much congestion, a sedative inhalation, such as benzoin, is beneficial, and, later, a stimulating inhalation, such as vap. pini sylvestris, will assist recovery. Long-standing congestion should be treated by astringents, applied either by means of a spray-producer or a brush. In cases of obstinate ulceration great benefit is sometimes obtained by heating calomel in the bulb of a glass tube and blowing it, whilst in a state of vapor, on the affected part.

*Leprosy.*—The chief feature of laryngeal leprosy is extreme thickening of the mucous membrane; sometimes papillary growths or tuberous masses are present. The larynx is never affected unless the disease is present in other parts of the body.

### Tumors of the Larynx.

*Carcinoma* is more often found in males than in females. Epithelioma is the most frequent variety, but encephaloid and scirrhus are said to occur. The subjective symptoms vary according to the stage of the disease and the part affected. Usually there is pain, confined at first to the larynx, but radiating to the ears and adjacent parts after ulceration has commenced. Dyspnœa and dysphagia follow sooner or later. Hoarseness is generally the most prominent objective symptom; it frequently precedes all others by a considerable period, but the voice is rarely entirely lost. When ulceration has commenced the breath may become excessively fœtid, and hemorrhage may occur from a vessel being laid open. The glands are seldom affected, and then only when the disease is at an advanced stage. This is due to the lymphatics being less freely connected with the glandular system than those from most other organs, and for the same reason general cachexia and secondary growths in other parts of the body are rare. The disease first appears as a swelling, situated most frequently on one of the ventricular bands, although any other part of the larynx may be affected; as it increases in size the outline becomes irregular, the color becomes red from congestion of the mucous membrane (though sometimes it is a dirty gray), and ulceration quickly supervenes. Œdema is generally present in the later stage.

**Treatment.**—All growths of a doubtful nature should be removed by an intra-laryngeal operation for microscopical examination. If found to be cancerous, two courses are open: (1) to leave the disease to run its course; (2) to attempt to eradicate it by surgical interference.

With a view to the latter, thyrotomy, partial extirpation, and complete extirpation of the larynx have been performed, but at present the results of these operations are not encouraging. Many patients die from the immediate effects

of the operation, and the disease is very liable to return, even after what appears to be complete removal. Thyrotomy cannot be recommended, in consequence of the difficulty of removing all the growth. The result of total extirpation of the larynx has been hitherto far from satisfactory. The percentage of mortality due to immediate effects of the operation is very high, and the pitiable condition of the patients who survive, even for a short time, detracts greatly from any advantage which may have been gained. The operation ought not to be performed unless the patient's sanction is obtained, after all the disadvantages as well as the advantages have been fully detailed to him. More may be said for a partial operation, especially if performed while the disease is still recent and apparently localized.

When the disease is allowed to run a natural course the average duration of life is eighteen months. If symptoms of stenosis arise, tracheotomy should be performed before the general health becomes lowered by insufficient aëration. Pain must be relieved by morphia, either injected hypodermically or insufflated into the larynx, and dysphagia met by the use of a feeding-tube or nutrient enemata.

*Non-malignant growths* most frequently occur in the larynx when congestion has lasted for some time, as in catarrhal or exanthematous laryngitis. Males are more frequently affected than females.

**Symptoms** vary according to the nature, size, and situation of the growth. When it is attached to one of the vocal cords, the voice is generally altered in tone, and if it is of any size dyspnœa is usually present.

*Papillomata* are the most common. They are usually of a pink color, but may be white or bright red, and are generally sessile, and often multiple. When removed they have a tendency to recur or to spring from a part of the larynx previously healthy.

*Fibromata* are of a brighter red, and round or oval in outline, though sometimes they grow out like cauliflower excrescences. They are always single and usually pedunculated; and the surface is generally smooth, though it may be rough, irregular, or wavy. There are two varieties, (*a*) the firm and (*b*) the soft. The former come next to papillomata in the order of frequency, and consist of bundles of white fibrous tissue covered with several layers of epithelium; the soft are comparatively rare, and consist of fibro-cellular tissue with serous fluid diffused through their substance.

*Cystic tumors* are not often met with; they are generally situated on the epiglottis or spring from the ventricle of Morgagni, and usually cause some local irritation.

*Myxomata*, or true mucous growths, *angeiomata*, or vascular growths, and *lipomata*, or fatty growths, are occasionally met with.

**Treatment.**—Most laryngeal growths can be removed through the mouth by means of forceps or a snare. If the patient is an adult, before the operation is attempted, the larynx and pharynx should be sponged with a 5 or 10 per cent. solution of cocaine; for a child 4 per cent. is sufficiently strong. When the parts are thoroughly anæsthetized, the patient should be directed to hold the tip of his tongue with a napkin in his right hand. The forceps and faucial mirror having been warmed, the mirror, held in the left hand, should be placed in position, and, as soon as a view of the growth is obtained, the forceps introduced, the blades being kept closed until the growth is reached. Unless the operator is skilled in intra-laryngeal manipulation, he ought not to attempt to cut or drag anything away unless he has seen that only the growth is between the blades.

Growths which are too tough to be extracted with forceps should be snared and slowly divided with the wire. Cysts may be crushed with forceps or laid open with a guarded lancet attached to a curved handle. After removal a solution of perchloride of iron, 60 to 120 grains to the ounce, should be applied every two or three days for a week or so, to prevent recurrence.

It may be necessary to anæsthetize a child before attempting to remove the growth. When this is done the child should be seated in an upright position on a nurse's lap, the mouth kept open with a gag, and the tongue held out by an assistant. The collection of saliva often prevents a good view of the interior of the larynx being obtained.

In very exceptional cases it may be desirable to destroy the remains of a growth with the electric cautery. When this is the case, a suitable electrode having been selected, all the platinum with the exception of the point should be insulated by tying a thin piece of ivory on each side of it (vaccine points do very well), and coating them over with a thick layer of gum-arabic. The larynx must be thoroughly anæsthetized, and the electric current not allowed to pass until the point is resting on the surface which has to be destroyed.

*An extra-laryngeal method of removing growths* ought not to be resorted to unless the growth is causing danger to life, and an experienced intra-laryngeal operator is of opinion that no other procedure will be successful. . This mode of removal is sometimes required when a growth is very large, has an extensive attachment, and is of very tough texture, or is situated where it cannot be reached through the mouth. It must, however, be remembered that the mere size, toughness, or extensive attachment does not justify an extra-laryngeal operation being performed.

### *Disorders of Sensation.*

*Sensory affections of the larynx* are occasionally met with associated with some other disease.

*Anæsthesia* occurs as a sequel to diphtheria and in bulbar paralysis. When present in a marked degree there is danger of pneumonia being set up by particles of food passing into the air passages.

*Hyperæsthesia* very often accompanies inflammatory conditions.

*Paræsthesia* is usually met with after a foreign body has lodged in the larynx, even when only for a short time, the sensation of its presence continuing for hours and even days after its removal. Sometimes this is associated with ill-health.

*Neuralgia* rarely occurs, and when present is merely a local manifestation of a general condition.

Electricity is of use in some cases of anæsthesia and in paræsthesia, if it persists; but when the latter has been caused by a foreign body, sedative inhalations or a few applications of an astringent to the affected parts are usually sufficient to effect a cure.

### *Muscular Paralysis.*

This may be due either (*a*) to disease or injury of the medulla oblongata or the nerves supplying the muscles, or (*b*) to affections of the muscles themselves. Among the diseases which produce these results may be mentioned syphilis, cancer, lead poisoning, rheumatism, and exposure to cold.

Pressure on a recurrent laryngeal nerve affects the abductor before the adductor filaments. This injury is liable to be produced by goitre, aneurysm, enlarged lymphatic glands, or thickening of the pleura at the apex of the right lung. When both groups of muscles are paralyzed, the vocal cord on the corresponding side remains fixed in the cadaveric position, *i. e.*, midway between extreme abduction and adduction, and on phonation the healthy cord is drawn to, or even over, the middle line, compensating for the immobility of the paralyzed cord.

*Paralysis of the abductor or adductor muscles* may be unilateral or bilateral. When only *one abductor* is affected the voice is usually unaltered, but there is more or less dyspnœa and stridulous breathing. When *both abductors* are paralyzed, the vocal cords lie almost parallel, but generally separated rather more behind than in front. The voice is usually but little altered; expiration is free; but inspiration difficult on the least exertion and attended with strido-, which is

causes, and is often met with in the se
the aphonia is usually constant, some
tone of voice, especially those at the b
is that coughing and sneezing are littl
nation, although the vocal cords are
left between them; sometimes one is
membrane of the larynx is usually pal

*The central adductor* (*arytenoidei*
with the lateral adductors, but may al
there is loss of voice, and although th
three-fourths of their length, they rema
posterior fourth.

*The external tensors* (*crico-thyroi*
quence of exposure to a draught of col
tinued use of the voice, especially in

The symptoms are: loss of voice,
is placed on one of the muscles dur
When the affection is bilateral the cen
during inspiration and raised in expir
of a wavy line.

*The internal tensors* (*thyro-aryten*
as a result of over-fatigue of the voice
When this has occurred, the vocal co
an elliptical aperture between them.

**Treatment.**—This must depend
tion. If congestion is present, seda
should be employed, and when it has s
muscles affected may be of service. T
tery to a metal disc fastened over the
round the patient's neck, and the oth
made by depressing the lever as soon
affected part of the larynx. In cases c
the aperture between the cords is seer
ment has been commenced, tracheoto
In many cases of functional aphon

*Muscular Spasm.*

*n of the adductors of the vocal cords* (*Millar's asthma*) is most fre-
et with in children between six months and two years old, after which
ndency decidedly diminishes. Males are much more subject to it than
nd those who are rickety are especially liable to be attacked.

cases are met with during the first few months of the year, in conse-
the more excitable condition of the child's nervous system at that time,
: upon confinement to the house during the winter months.

:ult dentition and intestinal irritation, produced by indigestible food
are the chief exciting causes. Sometimes the attacks occur during sleep,
nay be brought on by the child crying, sucking, or being dandled.

**ptoms.**—A severe attack begins with several short stridulous inspira-
)wed by a longer and more noisy one, after which respiration ceases,
s thrown backward, and the spine bent in the same direction. The
fixed or turn from side to side; the fingers are clenched over the
d the wrists flexed; the feet are flexed and rotated slightly outward,
eat toes adducted. The child's face becomes dusky, and the superficial
ended. Suddenly the spasm relaxes and the child recommences to
Usually the attacks recur from time to time, sometimes at frequent
but any one of them may prove fatal. Pyrexia is generally absent.

**tment.**—During the attack the child should be slapped on the back,
thrown on the face, and smelling-salts held to the nose. When the
passed off an enema should be given and a mercurial purge administered.
:w to diminish the tendency of spasms, musk (gr. 1–3) or bromide of
or potassium should be administered every three or four hours. The
tention must be paid to diet.

# CHAPTER XIV.

## *DISEASES AND INJURIES OF THE NECK AND THROAT.*

## MALFORMATIONS.

### Branchial Fistula.

The Eustachian tube is the modified first branchial cleft of fœtal life. The others usually leave no representative, but occasionally a fistulous opening is found at birth corresponding to one of them. The second and fourth appear to persist more frequently than the third; the former opens in the neighborhood of the lesser cornu of the hyoid bone, and may or may not communicate with the pharynx; the latter lies just at the inner margin of the sterno-mastoid immediately above the sternum. Occasionally it opens into the trachea or pharynx. They give rise to no symptoms and usually require no treatment. Pedunculated fibro-cartilaginous masses are sometimes found in the neighborhood of their external orifice.

Spina bifida, which occasionally occurs in the cervical region, nævi, hydrocele of the neck, dermoid cysts, and those developed in connection with the thyreoid body and the thyroglottic canal, congenital lipomata and malformations of the pharnyx, are described elsewhere.

## INJURIES OF THE NECK.

### Wounds.

Transverse incised wounds are frequently met with in the front of the neck. For the most part they are self-inflicted; many lie in the suprahyoid space, some in the thyrohyoid, and others over the larynx or trachea. Generally in right-handed people they begin on the left, high up, and run obliquely toward the right, becoming less and less deep; and not unfrequently they are jagged, the skin rolling up into folds before the pressure of the knife, so that it appears as if several cuts had been inflicted. Sometimes they extend from one side to the other, dividing the trachea and œsophagus or both the carotid arteries, and even notching the vertebral column; much more they are superficial, not penetrating, perhaps, into the deep fascia. There are various reasons for this: the edge of the knife in many instances is directed against the lower jaw, or the force is spent against the cartilages; when the head is thrown back the larynx is thrust forward and the vessels recede; resolution often fails at the last moment, and if the air-passages are opened the sudden collapse of the thorax, previously expanded to its utmost, is sufficient to interrupt the tension of the muscles and break the force of the arm. In this way the vessels escape unhurt in by far the larger number of cases.

Besides these, gunshot injuries and punctured wounds, stabs, for example, from behind, penetrating the apex of the lung, or involving the great vessels at the root of the neck, and even penetrating between the arches of the vertebræ into the spinal canal, are occasionally met with. Union by the first intention is the exception. It is almost impossible to keep the wound at rest, and partly owing to the elasticity of the skin, partly to the action of the platysma, the edges always curl inward, so that perfect adaptation cannot be obtained. Death may occur almost instantaneously from loss of blood, arterial or venous, from air being drawn into a wounded vein, from suffocation, owing to a detached portion of the tongue or one of the cartilages falling into the larynx or trachea, or from blood pouring into the lungs, or it may follow later from inflammation or other compli-

cations. Emphysema is not uncommon, but is rarely of much importance; spasm and œdema of the glottis may set in at any moment; food, dust, cold air, blood, or pus may find its way down to the lungs, and set up bronchitis or broncho-pneumonia; abscesses may form around the air passages, and spread into the tissues of the neck, and down behind the cervical fascia to the pleura and pericardium; and if these complications do not prove fatal, perichondritis and necrosis of the cartilages may set in; granulations may spring up and close the larynx or trachea; a fistulous orifice may be left, or aphonia, dyspnœa, or dysphagia may persist for the rest of life, caused by the cicatrization that takes place in the interior.

When the wound lies above the hyoid the facial and lingual arteries may be cut, the cavity of the mouth opened, and the tongue and the epiglottis hacked in such a way that they fall back over the larynx and cause instant death. The hemorrhage is usually free and the blood may pour down into the trachea as well as escape externally. Food and saliva pass out through the opening; the movements of the tongue are impaired (sometimes the hypoglossal nerve is divided); the elevators of the hyoid are cut across; and swallowing and vocalization cannot be properly carried out. If the thyrohyoid membrane is divided, the epiglottis and even the arytenoid cartilages may be detached and hang down; or the aryepiglottic folds may be cut, and the superior thyroid artery and superior laryngeal nerve divided.

When the brunt of the force falls upon the cartilages the great vessels usually escape; they lie far back in the angle, and unless the incision begins under the ear, or traverses the cricothyroid space they are generally well out of the way. The immediate risk, therefore, is not so great; but whenever the larynx is wounded, the danger of inflammation, of spasm and œdema of the glottis, and of food passing down into the air passages, owing to the imperfect way in which they are protected, is very serious. Dyspnœa and a sense of impending suffocation are always present; the least attempt at swallowing or speaking brings on fits of spasmodic coughing: and, if the patient survives, permanent impairment of the voice is not uncommon.

Hemorrhage is more frequent in wounds of the lower part of the neck; it may come from the carotid or thyroid arteries; from the anterior, external or internal jugular veins, or even from the thyroid gland, which, sometimes, when cut into, bleeds profusely; and, if the trachea is cut across, the blood may pour down into the lungs so as to cause instant death. Wounds of the trachea of themselves are not very serious; but when it is divided the two ends retract so that a wide space appears between them, the lower sinking down into the thorax and moving to such an extent with each inspiration that it is almost impossible to fix it. The œsophagus and the recurrent laryngeal nerve are often wounded at the same time. Punctured wounds at the root of the neck, if they involve the upper aperture of the thorax, are often fatal at once from injury to the great vessels; but instances are recorded in which recovery has taken place, even when the apex of the lung has been injured and the brachial plexus divided.

**Treatment.**—Hemorrhage must be stopped at once by pressure. If the vessel is a large one, the finger must be inserted into the wound and kept upon the bleeding point; division of one of the carotids is generally fatal immediately, but instances are on record in which the hemorrhage has been stayed temporarily in this way, until better means could be adopted. If the wound is too large, or there are many bleeding points, a handkerchief, or a sponge, may be used; but care must be taken not to compress the trachea or to drive the blood down into it. Then, as soon as possible, the arteries should be secured, either by torsion or ligature at both ends, and the veins tied. Complete division of the internal jugular is not necessarily fatal; a small lateral wound should be treated as if a branch had been torn off from the side. In deep punctured wounds, behind the angle of the jaw, when the bleeding is plainly arterial, and when it is impossible to secure the vessel without a long and dangerous dissection, an attempt should be made to ascertain by pressure upon the external carotid whether it proceeds from

convenience to the patient and without any risk. In all suicidal cases the patient must be carefully watched, for fear of doing himself further injury; sometimes it is necessary to restrain the hands, but when possible this should be avoided. Little can be done for the despondency that is so often present; if there is sleeplessness or much excitement chloral may be given; bromide is too depressing and opium is inadvisable in bronchitis. The prognosis in such cases is much worse than might be expected from the extent of the wound.

If dyspnœa arises the wound must be examined at once, and if necessary, tracheotomy performed. Occasionally this is required at a later period, owing to irregular contraction or cicatrization in the interior, or to the presence of exuberant granulations, which cannot be got rid of by scraping or cauterization. Quinine, carbonate of ammonia, ether and other stimulants must be given freely if pneumonia sets in; and the side of the chest may be enveloped in a poultice; but the signs are often too obscure until it is well advanced. There is no rise of temperature in many cases, and expectoration is absent; the face is pale and dusky, the forehead covered with beads of perspiration, the respiration short and jerky and the pulse small and quick. Generally the patient rapidly falls into a kind of stupor. Deep-seated abscesses and cellulitis of the neck are usually accompanied by rigors and high fever; and the local signs are well marked. Sometimes the inflammation extends along the outside of the trachea into the mediastinum, and causes pleurisy and even pericarditis. If a fistulous opening is left it may be cured by a plastic operation, paring the edges and bringing them together with numerous points of suture; or even by gliding a piece of skin over it from one side or the other, provided that it is certain that the patient can breathe sufficiently well when it is covered up.

### Fracture of the Hyoid Bone.

Owing to its protected situation this is rarely broken except by direct violence, such as a blow or a squeeze, as in hanging. The greater cornu is the part that usually gives way. One or two instances, however, are recorded in which it was produced by muscular action alone.

The **diagnosis** is seldom difficult: unless there is much swelling or ecchymosis, the fragments can generally be felt from the outside, and always by introducing the finger into the mouth. There is intense pain on pressure, or on attempting to speak or swallow. Very often the fracture is compound, one of the ends having perforated the mucous membrane, and there is a profuse secretion of saliva mixed with blood. Sometimes the swelling extends to the larynx, so that the dyspnœa becomes serious.

**Treatment.**—The fragments must be brought into position by manipulation, and the head and neck fixed, as far as possible, by a splint moulded over the shoulders and up the back of the head. Swallowing is so intensely painful, and sometimes sets up such an amount of coughing and irritation, that the patient may have to be fed by enemata for a few days, until the fragments are consolidated, or an œsophageal tube can be used. If the dyspnœa is severe, particularly if the fracture is compound, and if, as often happens, the wound becomes septic from the entry of food and other substances from the mouth, so that there is risk of acute laryngitis setting in, tracheotomy may be required at a moment's notice. Union generally takes place in three or four weeks, but suppuration, necrosis, œdema of the larynx, and septic pneumonia are not uncommon.

Dislocation of the hyoid bone, or displacement consequent upon relaxation of the ligaments connecting it to the thyroid cartilage, has also been described.

### Fracture of the Cartilages of the Larynx.

This may be caused in the same way; even the trachea has been torn across by a violent blow from the point of an elbow. The thyroid, owing to its size,

position, and rigidity, is the one that usually suffers: sometimes the cricoid is broken as well.

This accident may prove instantaneously fatal from obstruction or spasm of the glottis. Even when there is not much deformity the swelling, ecchymosis, and emphysema seriously narrow the rima glottidis and cause very alarming dyspnœa. In general there is the most intense distress, with a sensation of impending suffocation, or this may be absent at first and then come on suddenly. The treatment is the same as for fracture of the hyoid, but unless the portion of cartilage broken off is very small and altogether external, so as not to involve the mucous membrane, tracheotomy or laryngotomy may be required at a moment's notice. The latter is preferable, as the opening can be used to restore the displaced cartilage to its position or to fix it by sutures.

Contusion is much more common, and when severe—as, for example, in garroting—so that there is hemorrhage under the mucous membrane, may give rise to the same symptoms. It is said that sudden death has been caused by this or by spasm, without any fracture. Care must be taken not to mistake the crackling sensation that is often felt when the larynx is moved from side to side upon the vertebral column for cartilage-crepitus.

### Foreign Bodies in the Air Passages.

Irritating vapors rarely penetrate beyond the larynx: usually they are driven out at once by coughing, and cause merely a transient hyperæmia, though this may run on to inflammation. The same with liquids, unless the larynx has lost its sensitiveness or the muscles are paralyzed. After diphtheria, for example, or when a patient is under an anæsthetic, or after wounds involving the floor of the mouth or the upper part of the larnyx, when the mucous membrane is dry and insensitive, it is not uncommon for blood or liquid food or material vomited up from the stomach to find its way down through the larynx into the trachea and lungs, and, decomposing there, set up broncho-pneumonia. Solid substances cause symptoms of much greater intensity.

As a rule they enter by the mouth; occasionally they ulcerate through from the œsophagus, especially in malignant disease. In the vast majority of cases this accident is the result of the careless habit of holding things in the mouth or between the teeth, especially with children. Something or other—a laugh, or a blow upon the back—causes a sudden inspiration, and a foreign body is sucked down into the widely-open glottis and lodged in the air-passages before it is known that the hold on it is lost. Blow-tubes and pea-shooters are responsible for many, the child in filling its chest with air drawing the projectile into the larynx. In operations about the mouth, when the patient is under an anæsthetic, it has happened many times: sets of false teeth, or wedges used to hold the mouth open, or teeth dropped from the forceps after extraction, in the haste to grasp another, are all recorded as having fallen into the larynx. The same thing may occur in the vomiting that follows anæsthesia. A case of sudden death after the administration of ether was found to be due to the skin of a ripe plum rolled up; it had been vomited, drawn into the larynx, and was firmly wedged in the right bronchus, so that its end fell over and covered the orifice of the left. Round worms from the digestive tract, vomited during sleep, have been known to lead to the same result.

**Symptoms.**—These vary according to the position, whether it is in the larynx itself, in the trachea, or in the smaller bronchi. They may be immediate, due to obstruction or irritation, or secondary, caused by the inflammation that invariably follows sooner or later.

1. *In the Larynx.*—If it is large and round, so as to fit upon the rima glottidis, or sharp and angular, so as to cause spasm, suffocation may be immediate. The symptoms are of the most urgent description: the patient starts up wildly, gasping for breath, and clutching at his collar; the face is livid, rapidly becom-

ing cyanosed; the veins on the forehead and neck stand out like cords; he may be quite unable to speak, or if the larynx is not quite closed, utters the most distressing sounds, attempting at the same time to push his finger down his throat; expiration and coughing become more and more violent, until the body becomes convulsed, a cold sweat breaks out, and within a minute he falls down unconscious.

In most cases, however, the immediate effect is not so intense: if the foreign substance is smooth, so that it does not set up much irritation, or if it is lodged in some place out of the way, like one of the ventricles, the symptoms may be comparatively slight, although the patient is never free from danger. The cough is characteristic: it comes on in spasmodic fits of uncontrollable violence and often continues until the patient is utterly prostrate from exhaustion. The least change of posture is sufficient to induce it. At first it is dry without expectoration, but afterwards, when inflammation sets in, this may be copious, thick, and stained with blood. Sometimes, especially in children, the symptoms bear some resemblance to croup; but as a rule when they are due to a foreign body, expiration is more difficult than inspiration. Pain, a sensation of tickling often referred to the ear, and a sense of anxiety or of impending suffocation, are nearly always present. The voice may be quite lost from the first, or, if not, it always becomes hoarse in a few hours, from the swelling and œdema that follow. Later on, if the foreign body is sharp and angular, so as to cause inflammation and ulceration of the mucous membrane, death may ensue from spasm and œdema of the glottis; necrosis of the cartilages may occur; the inflammation may spread to the lungs and cause pneumonia; even blood-vessels may be ruptured, or the patient may die at length, worn out and exhausted. A coin, on the other hand, has been known to lie, coated over with mucus, in one of the ventricles for many months without causing urgent symptoms.

2. *In the Trachea.*—If the foreign body is fixed, like a puff dart, which lies with its point uppermost and with each expiration is driven further and further into the substance of the trachea, the immediate symptoms are not so striking. There is dyspnœa, but the cough is more continuous and is not of the same spasmodic, uncontrollable character. Aphonia is not present until the mucous membrane of the larynx becomes swollen from the constant effort at expulsion. Pain is always felt over the actual spot, and there is constant soreness behind the sternum. Inflammation, however, with ulceration and copious expectoration, very soon makes its appearance and extends rapidly to the lungs. If, on the other hand, the foreign body is free, the symptoms depend chiefly upon its shape and weight. At one moment it lies over the bronchi, generally the right, owing to the position of its orifice; the next, it is coughed up against the larynx, and starts a violent paroxysm. Sometimes the patient is so fortunate as to cough it out, with instant relief; sometimes, on the other hand, it becomes impacted in the rima glottidis, or is caught and held by the muscular spasm, and immediate death ensues. Often the patient is conscious that it shifts its position. Sometimes it can be heard and even felt from the outside.

3. *In the Lungs.*—When a foreign body is lodged in one of the bronchi there is rarely the same urgency. Dyspnœa, cough, copious expectoration, pain, and anxiety are all present, but the distress is not so extreme, and there is not the same sense of impending suffocation. If it lies in one of the large bronchi, valuable evidence may be gained from an examination of the chest. If the obstruction is only partial, the movement on that side is diminished, the respiratory murmur is fainter, and, generally, an unusual whistling sound is heard as the air rushes past the obstruction, unless this is drowned by the coarse *râles* caused by the large amount of secretion that is poured out. On the other hand, should the whole of one lung or one lobe be shut off, vocal fremitus and the normal vesicular murmur are wanting, and, after a time, the percussion note becomes dull, while the respiration in the rest of the lung is puerile.

Inflammation, when a foreign body is in the lung, may be long delayed

(especially if it is of an unirritating character), but it always breaks out at last. Suppuration sets in, abscesses form and lead to the destruction of the lung; gangrene, hemorrhage, or empyema may occur; tuberculosis may break out, and the end nearly always comes within a few weeks, though sometimes not for years. Only exceptionally has the foreign body found its way out at length through the wall of the thorax in the pus of an empyema.

**Diagnosis.**—In the absence of history this is often impossible; no single symptom is peculiar to this accident. Many cases have occurred in which the presence of a foreign body has never been suspected (especially in the lungs); and nearly as many in which the suspicion has been wrong. In children the difficulty is peculiar great.

Asphyxia may be caused by a foreign body driven into the pharynx; but as a rule, there is no time for exact diagnosis; if it is not dislodged at once by the patient's own efforts or by the introduction of the finger into the throat, instant laryngotomy affords the only hope.

Inflammatory affections, croup, especially in children, and laryngitis, are more difficult. The most important feature is the rapidity of the onset, and the extreme urgency of the symptoms, without, at first, any rise of temperature or sign of fever. In spasmodic croup, inspiration is more difficult than expiration. Hysteria, reflex irritation arising from disorders of the digestive tract, especially in children, spasm and œdema of the glottis, even aneurysm of the aorta, and whooping-cough, occasionally give rise to difficulty, especially if there is a history of a foreign body having disappeared from the mouth at the time of the onset. It is more common for a foreign body to be overlooked.

If the symptoms are very acute, particularly if there is violent suffocative cough recurring in spasms, it is probable the foreign body is in the larynx, or else that it is loose in the trachea, and is coughed up against it. When they are severe at first, and subside without expulsion, it has probably either become lodged in one of the ventricles or has passed down in the bronchi.

**Treatment.**—In some cases the symptoms are so urgent that laryngotomy (as being the most speedy) must be done at once with anything that is at hand. Even when the pulse can no longer be felt at the wrist, this may succeed with the help of artificial respiration. When not so urgent, and when, as usually happens, the patient is seen for the first time after the immediate paroxysm has subsided, the first thing is to ascertain the position.

If it is in the larynx it may be extracted by means of the laryngoscope and laryngeal forceps. A 5 per cent. solution of cocaine brushed once or twice over the mucous membrane renders it white and perfectly insensitive, so that thorough examination can easily be carried out without fear of spasm. Or the same effect may be produced, though not nearly so well, by the prolonged application of ice, by the inhalation of chloroform vapor, or by injecting a small quantity of morphia just over the superior laryngeal nerve, at the greater cornu of the hyoid bone. If this fails, the choice lies between subhyoid pharyngotomy, laryngotomy (or laryngo-tracheotomy, if more space is required) and vertical division of the thyroid cartilage, according to the nature and position of the foreign body. Then it must either be extracted through the wound or pushed up from below. In no case should a patient be left without assistance if there is a foreign body in the larynx or floating in the trachea, especially if there has been already a severe attack of spasmodic dyspnœa.

When it has passed beyond the larynx, and is fixed either in the trachea or in the lungs, there is not the same degree of urgency or of immediate risk to life. Tracheotomy, however, is usually advisable. It is true that it has been shown by statistics that in a very large proportion of cases expulsion takes place without; and, still further, that the percentage of deaths in those cases in which tracheotomy has been performed is higher than those in which it has not; but I think it will be granted that, given any individual case, the chance of safe expulsion is

much greater after the trachea has been opened, and that the risk to life is not appreciably increased by the operation. No cannula should be inserted; retractors, easily made with a piece of bent wire, should be fixed in the tracheal opening and fastened around the neck with an elastic band, so as to keep up a certain degree of tension upon the orifice, or Golding-Bird's dilator may be used. Sometimes expulsion is immediate, or the foreign body is coughed up so that it projects in the tracheal wound, or it is dislodged by inversion combined with compression of the thorax, especially if it is round in shape and of some weight; emetics and sternutatories have been successful, but no reliance can be placed upon them; or it may not happen for some days. There are many instances in which a cannula has been inserted and worn for some time, and then, quite unexpectedly, perhaps from changes it undergoes itself, or from ulceration around it, the foreign body has suddenly become detached and been expelled.

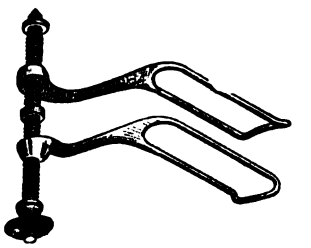

FIG. 349.—Golding-Bird's Dilator.

If this does not take place within the first four or five days, the air-passages must be explored with probes, hooked at the end, tracheal forceps (either Gross's, which are made of German silver, so that they can be bent to any shape, or Mackenzie's or Durham's which are so contrived as to open only at the extremities), and even with the finger. All these attempts cause violent expiration, and sometimes in this way, sometimes by being actually hooked up, foreign bodies have been extracted even from the right bronchus. Care must be taken, however, not to mistake the rigid angle between the bronchi for one. Much depends upon a knowledge of the shape; tubular bodies may be laid hold of at the margin, or drawn up by passing both blades of a pair of forceps inside, and then separating them; the worst of all are puff-darts, which become firmly wedged in.

Afterward the same precautions must be taken as after tracheotomy; the patient must be confined to his room, the air kept warm and moist, the wound covered with moistened gauze, and, so long as there is any fear of spasm or œdema of the larynx, the cannula should be retained and the patient fed by an œsophageal tube. A certain amount of thickening and irritation of the mucous membrane, with profuse expectoration, and, possibly, the growth of granulations, is very likely to persist for some time.

In older cases, when some length of time has elapsed since the entry of the foreign body, the question of surgical interference must be guided mainly by the condition of the lungs.

## SCALD OF THE GLOTTIS.

In gas explosions and fires the pharynx is occasionally burnt, from the heated air or flame being drawn into the mouth; scalding is more common, especially in young children, from trying to drink out of the spout of a kettle. In either case the chief danger arises from the injury to the upper part of the larynx, which may be badly hurt from the flame or steam being sucked down into it by the inspiration which precedes a scream. The œsophagus usually escapes, unless there is a determined attempt to drink the fluid, and it is thrown at once to the back of the mouth.

Unless the accident is seen, or there is other external evidence, the diagnosis must usually be made from the sudden onset of extreme dyspnœa. The lips and mouth may be blistered, but they often escape, as the fluid passes right to the back and is ejected through the nose. There is constant screaming, until, partly from exhaustion, partly from swelling and œdema, the voice is completely lost, and nothing can be heard but a hoarse, croupy inspiration. Dyspnœa may be

(especially if it is of an unirritating charact... severity after a few hours. Suppuration sets in, abscesses form and lead ...ening; the pain is very s... grene, hemorrhage, or empyema may occur ... most impossible; and even end nearly always comes within a few we... the most terrible appreh... Only exceptionally has the foreign body fo... ...ger is introduced into the wall of the thorax in the pus of an empyem... ...s can be felt hard and sha...

**Diagnosis.**—In the absence of hist... ...back from each side of t... symptom is peculiar to this accident. ... ...ed bodies, which project u... presence of a foreign body has never b... ...e of the aperture of the laryn... and nearly as many in which the susp... ...t. These are the aryepiglot... difficulty is peculiar great. ...come œdematous and swel...

Asphyxia may be caused by a fore... ...ident that when the tongue is a rule, there is no time for exact diag... ...y be seen as shining, rounded... patient's own efforts or by the introd... ...masses, reaching nearly to the laryngotomy affords the only hope. ...severe cases the mucous mem...

Inflammatory affections, croup ... ...se of the epiglottis, the false more difficult. The most importan... ...and even the larynx below the extreme urgency of the symptoms, v... ...re more or less in the same con... of fever. In spasmodic croup, ... Hysteria, reflex irritation arising f... ...occur from asphyxia within a in children, spasm and œdema o... ...the accident; more often the whooping-cough, occasionally giv... ...es worse and worse; the voice of a foreign body having disappe... ...ost; inspiration is hoarse and is more common for a foreign b... ...wer ribs sinking inward at each

If the symptoms are very ... ...rfectly quiet, with its chest thrown cough recurring in spasms, it i... ...greatest muscular aid. The face is that it is loose in the trachea, ... ...covered with beads of perspiration at first, and subside without ... ...t suffocation. Later, if spasm of one of the ventricles or has p... ...ately fatal, death may occur from ... extension of the inflammation, or

**Treatment.**—In some ... ...ghtest case the prognosis is very un- (as being the most speedy) ... Even when the pulse can n... ...nt the inflammation spreading, and help of artificial respiratio... ...is is inflamed, and the cavity of the the patient is seen for the ... ... one that under ordinary conditions first thing is to ascertain ... ...ring on an attack of fatal spasm.

If it is in the larynx ... ...ment, however placing the child in a laryngeal forceps. A 5 ... ...neck by means of a collar; leeches the mucous membrane r... ...be kept perfectly quiet, sitting up. examination can easily ... ...of the mucous membrane may be kept may be produced, thou... ...doses of calomel (gr. j to gr. ij) every by the inhalation of ch... ...s, or very small ones of antimony or just over the superior ... ...if the fever is setting in with severity: this fails,. the choice ... ...um for example, which does not cause laryngo-tracheotomy. ... ...spnœa continues to increase, particu- thyroid cartilage, ac... ...and if the chest-wall is beginning to it must either be ext... ...on of the aryepiglottic folds, intuba- case should a patie... ...s easily carried out with an ordinary larynx or floating ... ...within a third of an inch of the point attack of spasmodi... ...nger of the left hand acts as a guide.

When it has ... ...anger. I have known this followed by in the lungs, ther... ...temporary. Tracheotomy, ho... ...t, and requires special appliances, such statistics that in ... ...is or tracheotomy must be resorted to. and, still further ... ...ing relief. It is true that, especially in otomy has been ... ...peration, and adds an additional cause will be granted ... ...monly sets in; but, it enables the child

; it prevents exhaustion and the continued
e of the lung and the danger of hepatization;
on against spasm. If it is reserved to the last,
re already desperate, the ill-success that attends
he credit of the operation.

## MMATORY AFFECTIONS.

position, all the tissues of the neck are very liable to
; the spine, for example may become the seat of tu-
hritis; the muscles may be attacked by rheumatism;
hem (especially in the sterno-mastoid); or the sheaths
involved; but, with the exception of the cellular tissue
, separate description is not required.

### Inflammation of the Cellular Tissue.

y serious from the arrangement of the cervical fascia. It may
ed wounds (either of the skin or the mucous surfaces); by in-
blood-stream, as in pyæmia, or by extension from some neigh-
isease, alveolar abscess for example, suppuration in the floor of
ing operation, tonsillar abscess, and especially the periglandular
at occurs in scarlatina and diphtheria. The intense depression
of these disorders, lowering the vitality and the power of resistance
, is probably the cause why it spreads with such rapidity and so

mptoms are very grave from the first; often there is a rigor; the tem-
ses rapidly; the pulse is quick and feeble and delirium soon sets in.
is intense; the head is fixed; the tongue, if the sub-maxillary region is
, forced up into the mouth; the jaws hardly able to move; and swallow-
ost impossible. The skin is swollen and puffy; the superficial veins are
ded, and all the tissues of the neck hard and tense. If left to itself, the
a may yield and allow the exudation to make its way toward the surface and
nt by the side of the neck; but the inflammation is more likely to spread, in-
lving one layer after another, until either the patient dies from acute blood-
oisoning, or the mediastina are implicated, and pleurisy, pericarditis, or retro-
sternal suppuration is added to the rest.

Early and free incision is the only course. The patient should be placed under an anæsthetic; an incision, an inch and a half or two inches in length, made over the most prominent part of the swelling, the deep fascia divided to the same extent upon a director, and if this does not give sufficient relief, the point of the director thrust into the middle of the swelling, and followed up after Hilton's method, with dressing forceps. Afterward a large drainage tube should be inserted, and the discharge encouraged as much as possible. The direction of the incision must be parallel to that of the main vessels, and it must be very carefully made, as it is not always possible to ascertain how far they are displaced.

Even when the inflammation is not so severe as this, extensive destruction is by no means uncommon; and sometimes, especially after scarlatina, profuse hemorrhage occurs about the time that the sloughs are separating. If it comes from the carotid or the jugular, an attempt must be made to find the bleeding point and isolate it for ligature, tracing it for some little distance up or down, as the case may be, so as to get clear of the sloughing part; but if, as usually is the case, this is impossible, all that can be done is to apply styptics and pressure. The cavity must be cleansed and dried as thoroughly as possible, well covered with iodoform, and then plugged with iodoform gauze; but the prognosis is very grave.

with disease of the central nervous system—is seldom met with until late in life, and is distinguished by the clonic character of the convulsions. The head can only be kept at rest by means of some external support; as soon as it is left the muscles are seized with clonic spasms, which grow worse and worse as the patient attempts to control them. Sometimes one side only is affected; more frequently both, and in many instances other muscles as well. Massage, galvanism, counter-irritation, faradization of the opposing groups, and many other remedies have been tried without much benefit. Occasionally relief is obtained by bromide of potash, but it seldom lasts long. Neurectomy of the spinal accessory holds out a better prospect when only the sterno-mastoid is involved, especially if a large portion of the nerve and its connections with the cervical plexus are removed; but in most instances the other muscles are affected as well.

## Tumors of the Neck.

A very large number of the tumors of the neck are of congenital origin, although they may not begin to enlarge or become prominent until late in life.

*Nævoid growths* are fairly common. In most cases they consist of nothing but dilated veins and capillaries (the so-called blood-cysts of the supra-clavicular region); but not unfrequently they are associated with a variable amount of fibrous and fatty tissue, or with hydrocele of the neck—in all probability a similar affection of the lymphatics. They can usually be recognized by the effect of gentle pressure; but, if there is much solid tissue, or many phleboliths, and if the history is vague, the diagnosis is simply a matter of conjecture. The only satisfactory treatment is excision; but as they may extend long distances under the muscles (in one case of a mixed nævoid and lipomatous growth under my care, the supra-clavicular and subscapular regions were completely dissected), and, not unfrequently, communicate with the jugular veins, the operation should not be lightly undertaken.

*Hydrocele of the neck, congenital cystic hygroma*, or *lymphangeioma cysticum*, has already been described. It may be present at birth, or may not cause any conspicuous enlargement until adult life. Sometimes it occurs under the jaw, more frequently in the supra-clavicular region, extending into the axilla. It may be unilocular (the term hydrocele of the neck is sometimes reserved for this) or composed of numbers of cysts of all sizes, mixed with fibrous or fatty tissue. Generally the fluid they contain is clear and serous, but it may be red, chocolate-brown, or green, according to the amount of blood mixed with it and the changes it has undergone. Naturally, therefore, the degree of translucency is very variable. These growths not unfrequently extend very deeply into the neck; they may pass the middle line, reach down into the thorax, surround the great vessels, and even extend upward into the occipital region. Generally part of them is superficial and the diagnosis easy, but sometimes they are altogether buried behind the trachea, or in the mediastinum, so that it is impossible to ascertain what their nature is. In some instances a fatal result has been caused by pressure upon important organs; in others, it has followed from deep-seated suppuration; disappearance, without operation, is very unusual.

The treatment must be very cautious. Simple cysts may be tapped and drained, and the same thing may be done in the case of individual ones of larger growth; but, though this gives temporary relief, they often refill. Injections of iodine and setons have succeeded, but in many cases they have caused diffuse attacks of inflammation, and even death has occurred. Excision is only possible when the growth is small and superficial. Repeated incision and drainage, carefully avoiding suppuration, offer the best prospect.

*Hyo-lingual Cysts.*—Another variety originates in connection with the hyo-lingual canal. This extends in the fœtus from the foramen cæcum to the hollow of the hyoid, and thence onward to the pyramidal process of the thyroid bone. It is developed from the stomatodæum (the lingual portion probably

from the hypo-pharyngeal diverticulum, around which the thyroid originates. In the infant the former often persists; the rest usually disappears or remains, as the levator glandulæ thyroideæ, the pyramidal lobe itself, the ligament extending from it, or the cysts that are so frequently developed near its apex. Some of the cysts that are formed from this are dermoid, containing sebaceous matter and hair (the lingual canal itself is epiblastic); others are simple and unilocular, filled with serum; in others again, papillomatous and villous growths make their appearance (these are usually regarded as accessory thyroids, and may occur in the larynx and trachea), and sometimes again, they undergo malignant degeneration, and pass into a form of cystic epithelioma.

*Branchial Cysts.*—Congenital cysts, growing down to and involving the sheath of the great vessels, may develop from the lining of the branchial clefts at the side of the neck. Sometimes they are associated with branchial fistula. Their contents (they may be sebaceous or mucous) vary according to the character of the epithelium from which they spring.

In addition to these growths of congenital origin, tumors of all kinds originate in connection with the various tissues and structures in the neck. Sarcoma, lipoma, fibroma, and even enchondroma, may develop in the cellular or fibrous tissue (the last-named possibly from rudiments of the branchial cartilages); exostoses, enchondromata, and myeloid sarcomata from the bones; fusiform and sacculated aneurysms, arterio-venous aneurysm and aneurysmal varix from the vessels, and molluscum, sebaceous cysts, papilloma, and epithelioma from the skin.

The lymphatic glands present still greater variety. In addition to lymphoma, lymphadenoma, and sarcoma (growths originating in them), and to the various forms of specific inflammation (tubercle, syphilis, glanders, leprosy, etc.), which affect them and cause them to enlarge to such an extent that they are often designated tumors (in spite of their inflammatory origin), they are liable to be the seat of secondary malignant growths of all kinds. Epithelioma of the lip and tongue affect the submaxillary ones; sarcoma of the tonsil, those along the carotid sheath; scirrhus of the breast, the supraclavicular chain; and epithelioma of the œsophagus, the deeper ones that run down to the mediastinum. Carcinoma of the larynx, on the other hand, does not extend to them until late in the course of the disease. Epitheliomatous glands in the neck, especially behind the angle of the jaw, are peculiar in often becoming cystic, the central mass undergoing caseation and liquefaction. When this occurs, they increase rapidly in size, the skin over them becomes red and thin, and, not unfrequently, they burst and give way, discharging a mixture of caseous debris, blood and serum. Sometimes the hemorrhage is very serious.

*Tumors in connection with the thyroid body* (which are described separately) are distinguished by their rising and falling with the trachea in deglutition. *Bursal cysts*, which may occur over the thyroid cartilage, or the thyro-hyoid membrane, are known by their chronic character, by the age at which they occur, and by the thinness of their walls and the character of their contents.

Hernia of the pharynx (*pharyngocele*) or œsophagus (a protrusion of the mucous membrane through a defective portion of the wall, causing a great sac to develop behind the carotid vessels) may be diagnosed by its position, the variation in its size from time to time, and the passage of a sound. It may be congenital or acquired; but if it gives rise to inconvenience, the only course is to excise it. *Tracheocele* (a similar protrusion between the cartilages of the larynx or trachea) is distinguished by its containing air, and by the variation in its size on forced expiration; usually it projects in front.

Gummata may occur in the muscles, especially the sterno-mastoid, or masses of bone may develop in them as a result of osteo-arthritis, or after strains. The sterno-mastoid induration of infants is probably traumatic, due to partial rupture and coagulation of the blood inside the sheath.

### Operations on the Air Passages.

*Laryngotomy* is performed in the crico-thyroid space. It is not suitable for children, and only for adults in cases of emergency or when a tube has to be used for a short time, during an operation, for example. The space is much too small (unless the cicro-thyroid and lateral crico-arytenoid muscles are incised) to admit of the removal of a foreign body or a papilloma.

The question of an anæsthetic depends upon the urgency of the operation. The patient's head is thrown back as far as possible, while the neck rests upon a firm support, and the crico-thyroid space identified. A longitudinal incision is made exactly in the middle line over this, and the larynx opened by dividing the membrane transversely immediately above the cricoid cartilage. The crico-thyroid arteries are seldom injured, but if there is any hemorrhage the bleeding points can be secured at once with Wells' forceps. A laryngeal cannula, which is shorter than an ordinary tracheal one and flattened from above downward, can then be fitted in at once.

*Trachcotomy* is required much more frequently. It may be performed for the relief of obstruction, whether it is temporary (as in croup, diphtheria, œdema of the glottis, or muscular spasm) or permanent (as in syphilitic stenosis); for the removal of foreign bodies; to give rest to the larynx in cases of painful ulceration; or as a precaution in operations in order to prevent the entry of blood.

The trachea may be opened either above or below the isthmus of the thyroid; but, unless there is some special indication to the contrary, the former should always be selected. The anterior jugular and inferior thyroid veins are in close relation with the lower part. The innominate artery bifurcates almost on it, and sometimes reaches far up into the neck. The thyroidea ima may cross it. It lies very much further from the surface and is much more easily displaced to one side. In infants, too, the thymus may cause a certain amount of difficulty.

Except in cases of great emergency, an anæsthetic should always be given. Chloroform is better than ether, as it is less irritating: very little is required, especially in the case of children, as it is not necessary to induce absolute anæsthesia. The recumbent position is the most convenient, the head, if the breathing will allow it, being thrown back, and the neck supported by a small but firm pillow or sand-bag. As there is sometimes a little difficulty in identifying the cricoid cartilage, a careful examination must always be made first.

The incision must be two inches in length, beginning on the margin of the cricoid cartilage (unless it is wished to include this, as in laryngo-tracheotomy), dividing the skin and exposing the anterior layer of the deep fascia. If the assistant holds the head perfectly straight and the surgeon's hand is a light one, there is no need to fix the trachea yet. The skin can be made sufficiently tense by drawing it down upon the sternum. The next step is to identify the white line that marks the interval between the muscles. At this level they are not in contact, and the only structure in front of the trachea (with the exception of veins) is the cervical fascia that passes across from one to the other. To see this clearly the edges of the incision must be gently separated with the forefinger and thumb of the left hand, steadying the trachea without compressing it. Retractors held by an assistant nearly always displace it.

The next proceeding varies according to the operator. Careful dissection with a scalpel until the rings of the trachea are thoroughly exposed used to be the invariable rule, but now there are many modifications. Whitehead advocates splitting the fascia from above downward with a raspatory (even a steel director may tear the veins) until the isthmus is reached. This is pushed down, and the trachea laid bare at once. Parker only makes two incisions, one to expose the white line, the other from below upward, through it into the trachea. Bose recommends a transverse incision through the fascia on the cricoid cartilage; a blunt hook is then introduced into the slit and passed down behind the thyroid, and everything that lies in front pulled toward the sternum until the first three

rings are exposed. This has been called the bloodless method, and may be practiced when there is a large plexus of distended veins, so placed that it would be difficult to avoid injuring them in any other way.

Parker's method undoubtedly shortens the operation, avoids shock, and lessens the size of the wound and the absorbing surface (a matter of great moment), but it can hardly be recommended unless the operator is thoroughly experienced. In actual practice each case must be judged upon its own merits: in some, it may be advisable to open the trachea at once; occasionally it must be done, as respiration may cease with the shock caused by the first incision; but in all alike it is necessary to expose and recognize the interval between the muscles, to keep exactly

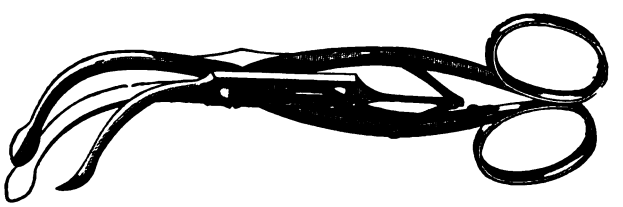

FIG. 351.—Trachea Dilator.

in the middle line, to avoid wounding the veins, and to make the deep incision from below upward. Undoubtedly it is safer not to open the trachea until it is thoroughly exposed; and this should be the rule; but, on the other hand, tedious dissection is equally to be avoided.

The isthmus of the thyroid gives very little trouble: it can be pressed up or down by the finger without difficulty. [Some operators prefer to divide the isthmus between a double ligature.] Great care must be taken to open the trachea exactly in the middle line. The upper three rings should be divided, but not the cricoid. As soon as this is done the edges of the tracheal wound should be held

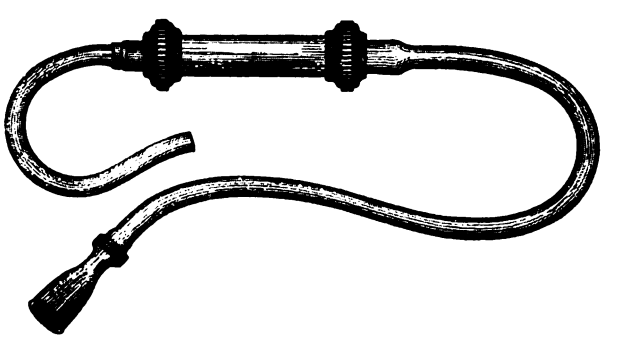

FIG. 352.—Parker's Suction Apparatus. The cylinder is filled with antiseptic cotton-wool.

open with dilating forceps until the immediate disturbance consequent on the change of breathing has subsided. Sometimes respiration ceases altogether, the abundant supply of oxygen causing apnœa. Sometimes rapid expiratory efforts are made: coughing, of course, is impossible. In cases of croup or diphtheria advantage may be taken of this to clear out any false membrane that can be seen. Parker recommends sweeping round the interior of the windpipe with a feather dipped in a solution of soda or borax in order to detach and bring away as much as possible; and, if this does not succeed, suction either by means of a ball-aspirator or a properly guarded mouth-tube (Fig. 352). The immediate application of the mouth to the wound must be absolutely condemned.

The size of the trachea differs even at the same age, and this, of course, determines the diameter of the cannula; its shape must depend upon the part of the windpipe opened. Durham's and Parker's (Figs. 353 and 354) are the most satisfactory, the latter, however, owing to the absence of a guide, is occasionally a little difficult to introduce. Quarter-circle and bivalve tubes should never be used. Morrant Baker's rubber ones answer exceedingly well when the wound has assumed a definite shape, the amount of discharge often beginning to diminish at once. In most cases a double tube is necessary for purposes of cleansing (Parker dispenses with it when there is a well-trained nurse), and the inner one should project slightly beyond the outer, so that the latter may not become clogged. In addition, the collar of the tube should be movable, that it may accommodate itself to the action of the trachea in swallowing.

There need not be any hurry about the introduction of the tube; the wound can be held open with dilating forceps for a minute or two, the trachea thoroughly cleared, search made for a foreign body (in this case it is sometimes advisable to fix the edge of the trachea temporarily to the skin), or a suture passed through the lower part of the wound ready to fasten. Then the cannula may be quietly introduced on a pilot, if its construction admits of it, and, the guide being withdrawn, secured by means of a tape round the neck. In this way there is no fear either of

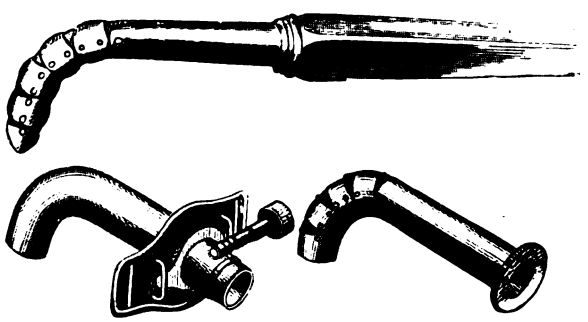

FIG. 353.—Durham's Cannula with Pilot.

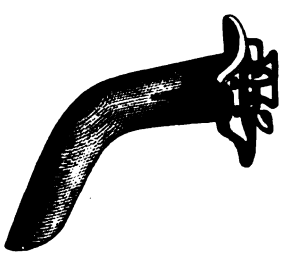

FIG. 354.—Parker's Cannula.

passing the tube between the trachea and the fascia or of leaving it in its proper position, but blocked with false membrane.

No operation in surgery is so frequently bungled as tracheotomy; easy as it appears on the dead subject, on a child with a short, fat neck, suffering from extreme dyspnœa, it is entirely different. Waste of time should, of course, never be permitted, but hurry is a great deal worse. The cricoid cartilage has been mistaken, the trachea pushed to one side and missed altogether (it is very easy in a child), the opening hacked or made on one side, the posterior wall cut into, important veins wounded, and the carotid, the innominate, and even the sac of an aneurysm laid open. This cannot happen if the head is held straight, the incision made of sufficient length and exactly in the middle line, and if the operator feels from time to time what he is doing. If, after the first incision, he presses the skin on either side backward with his thumb and forefinger, the trachea is fixed in the middle between them without being compressed, and is kept well up in the wound.

Hemorrhage occasionally is unavoidable. If an artery is cut its end should be clamped at once, and a large vein may be treated in the same way. Generally, however, the source cannot be detected; it comes from the small vessels of the plexus between the layers of the fascia, all of which are distended, owing to the dyspnœa. In these circumstances it is often advisable not to wait, but to open the trachea at once; as air enters and the right side of the heart becomes relieved, the veins empty themselves and the hemorrhage ceases. Holding the

trachea slightly forward with the dilating forceps helps to compress them and prevents the blood entering the lungs.

When tracheotomy is performed as a precautionary measure to prevent the entry of blood into the lungs during the course of an operation, the incision and various steps are the same, but a tampon is inserted instead of a simple tracheotomy tube. The two best known are Trendelenberg's and Hahn's. Each consists of a tracheal tube, but in the former a dilatable rubber collar is used to block the space around it, between it and the mucous membrane, in the latter compressed sponge. Of the two this appears to be the better; it is not so likely to slip or give way, but in all operations, except those on the larynx itself, a simple tracheotomy tube with a sponge (attached to a string), to block the upper aperture of the larynx, answers equally well, and is not nearly so likely to get out of order.

FIG. 355.—Hahn's Tampon Cannula covered with compressed sponge impregnated with iodoform.

**After-treatment.**—This varies naturally with the cause; it must always be remembered that tracheotomy only relieves a symptom or prevents one; the original trouble still remains.

(*a*) In the simplest case—chronic laryngeal stenosis, for instance, in which there is no pulmonary complication—all that is needed, provided the tube fits, is something to warm and moisten the air before it enters the lungs, and a dry absorbent dressing around the orifice to diminish the amount of discharge and lessen the risk of broncho-pneumonia and cellulitis. The patient should be kept as quiet as possible in a semi-recumbent position, and well protected from draughts. A bronchitis kettle may be used, but it is better, for a time, at least, to protect the orifice with a thin, flat sponge, wrung out of hot water, so as to filter the air thoroughly. The wound should be powdered with iodoform, and the flanges of the cannula prevented from pressing upon it by little pads of absorbent wool. The frequency with which the tube requires changing depends upon the amount of irritation it causes; a rubber one can often be introduced on a proper dilator by the second day. In cases such as these, there is very little of that tenacious mucus which is so troublesome in croup or diphtheria.

For the first few days the patient should be fed through the rectum; the movements of the trachea in swallowing are very painful (cocaine sprayed over the wound prevents this to some extent), and there is great risk of fluid trickling down the larynx and passing by the side of the tube into the lungs. This may happen even after the cannula has been removed, if the larynx has not thoroughly recovered, but usually there is no danger after the wound has healed, and the patient has grown accustomed to the change of respiration and learned how to cough. If the rectum becomes irritable or thirst is distressing, an œsophageal tube should be used instead.

Tracheotomy tubes, if worn permanently, should be frequently changed and carefully inspected from time to time. Their duration of life varies very much, and instances have been known of their breaking and of the end falling down into the bronchi. It is always as well to protect the orifice with a suitable respirator.

(*b*) In diphtheria the after-treatment requires even greater care. The air must be warmed and moistened, and the cot surrounded by screens, but the top should be left open. The tube must be kept clean by means of feathers dipped in a solution of bicarbonate of soda or potash (soda bicarb., gr. xx; glycerini, ʒss; aq. ad ℥j), and if there is any membrane heard or seen floating in the trachea or larynx it must be cleared away in the same manner. Parker recommends that the solution should be sprayed from time to time over the wound to prevent the viscid mucus collecting and drying around the orifice. The frequency with which the inner cannula requires changing depends upon the success with which this is carried out. At first it may need it almost every hour, but it must be remembered that the process is an exhausting one, and, for a time, very alarming to a child, so that every endeavor must be made to keep the passage free without. Each cannula

should have a double set of inner tubes, so that when one is removed and a feather has been passed down the outer to make sure it is clear, the second can be introduced without delay. The outer need only be removed once a day. To clear them they should be placed in a hot solution of soda and well scrubbed.

How long the tube should be continued depends upon the course of the disease; but, in any case, the metal cannula should be replaced as soon as possible by a rubber one (it can usually be done by the third or fourth day) and this should not be worn longer than is absolutely necessary. Before leaving it off an attempt must be made to educate the larynx again, and to reduce the amount of air passing through the tube, by using one that is perforated on the convexity or very much shortened. The child, of course, must be watched night and day by some one who can use dilating forceps and replace the cannula at once if there is any real danger.

Instances of very great difficulty are met with every now and then; dyspnœa comes on as soon as the tube is removed, and the child seems absolutely unable to breathe through its larnyx. In a few cases this is due to a mechanical impediment, cicatricial stenosis, or the growth of granulations from the mucous membrane, caused by the irritation of the cannula; but in the majority no reason of this kind can be found, nor can more than a small proportion be accounted for on the hypothesis of diphtheritic paralysis. Probably it arises not so much from any structural alteration as from the inability of the child to direct its efforts with sufficient energy, and from actual fright. Most cases recover as the child grows stronger by patiently trying again and again; sometimes galvanism is of service, but in a few nothing succeeds, and, then, if no organic obstruction can be found, the only course left is intubation—passing a tube into the larynx, through the mouth or through the wound, and retaining it there. Either O'Dwyer's or McEwen's can be used; the essential point is that the lower end should be just below the level of the tracheal opening. A tube of this kind can be left without being removed for twenty-four hours or longer; but if it becomes blocked, so that it cannot be cleared by coughing, or if symptoms of exhaustion come on owing to the distress it causes, it must be removed at once, and under no circumstances may the child be left alone for a moment.

**Prognosis.**—Care must be taken to distinguish between the consequences of the operation and those of the disease for which it is performed. Much depends upon the age of the patient; in an infant it is always serious, the structures involved are so small and delicate, and there is such great risk of pulmonary complications, independently of croup or diphtheria. If the lungs are already collapsed and partially consolidated, if the patient is exhausted by prolonged battling against imminent asphyxia, or if he is dying from the diphtheritic poison, the operation can do no good; it must not be blamed for the result, but it may hasten the end. If it is to be of any real service, or if the wound is to be used not merely to relieve a symptom but to attack the disease by removing false membrane and giving the patient pure air, not that which has been befouled by passing over a poisoned surface, it must be performed while there is still a reasonable hope.

Inflammation of the cellular tissue of the neck is the most common complication. There is always a little at the first, causing a certain amount of swelling and œdema around the wound, but it is seldom serious unless the parts have been much disturbed in the operation or the vitality of the tissues is greatly impaired. Usually it subsides in the course of a few days; sometimes, however, it forms an abscess around the trachea (especially if the tube has missed the opening when it was being introduced), and occasionally it leads to diffuse suppuration, which may even spread down to the mediastina and involve the pleura or pericardium. Care must be taken that the tape fastening the cannula is not too tight.

Irritation of the mucous membrane of the trachea may be caused by the end of the cannula. Usually this is due to the fact that it does not fit. Ulceration of the anterior wall, leading to perforation, was a common result when quarter-circle tubes were used, and though this is much more rare at the present time, masses of

granulations due to the constant friction of the end are not unfrequent. Slight cases, if the growth is easily accessible, may be relieved by means of an alum spray, or by painting it with an astringent solution; more severe ones may require an enlargement of the wound and the application of the cautery or a curette. In a few very rare instances the trachea remains irritable, even when a rubber tube is worn, without any perceptible cause.

Diphtheria very seldom attacks the wound. It may become foul and sloughy from the constant irritation, but it is rare to find a definite adherent membrane. If it forms it must be destroyed at once.

Emphysema is sometimes met with, especially when the cervical fascia is opened up irregularly, and it is said that the air may spread in the tissues until it reaches and fills the pleura.

In addition to these there is always, the risk of bronchitis and broncho-pneumonia, caused by the entry of cold or dry air, foreign bodies, dust, food, blood, or the secretion of the wound; and, of course, all the ordinary complications of irritated wounds, such as sloughing, erysipelas, etc., may occur as well.

*Laryngo-tracheotomy.*—In this operation the cricoid is divided as well as the upper rings of the trachea. It may be required in the case of children with very short necks, or be advisable when there is a growth or a foreign body in the larynx. Under other circumstances it should not be performed, as it is liable to lead to serious impairment of the voice.

*Subhyoid pharyngotomy* (opening the pharynx through the thyro-hyoid membrane) has been performed for the removal of growths and foreign bodies in the larynx. It should only be resorted to in cases in which extraction by the aid of the laryngoscope has failed or is unsuitable.

*Thyrotomy.*—Median longitudinal division of the thyroid cartilage may be required under similar circumstances. Laryngo-tracheotomy is performed first and a tracheal tube inserted; in the case of papillomata, which are often very vascular, a tampon is advisable to prevent any blood trickling down the trachea. In some cases this, or the division of the crico-thyroid membrane, is sufficient; if not, the incision is carried upward and the two halves of the thyroid cartilage separated. The greatest care must be taken to keep exactly in the middle line, and if possible avoid wounding the anterior commissure of the cords. In children and young adults the incision may be made with a scalpel, and it may not be necessary to divide the whole length; the elasticity of the parts is so great that sufficient room can be obtained without. In old people this is not possible, and in many instances a fine saw must be used. After the growths have been removed and the base from which they spring seared with chromic acid, the margins of the cartilage must be accurately adjusted and secured with wire sutures passed through the perichondrium. The tracheal tube should be left for some days, until all danger of inflammation is past and the parts are fairly well united. The patient must in the meanwhile be kept perfectly quiet; talking, and especially coughing, prevented as far as possible; and all sources of irritation avoided. The voice is very likely to be impaired: not, perhaps, so much from inaccurate adjustment as from the subsequent cicatrization and contraction.

### Intubation of the Larynx.

This method of treating temporary occlusion of the glottis has recently been revived by MacEwen (for adults) and O'Dwyer. The former employs long cylindrical tubes after the pattern of gum-elastic catheters, introducing them through the mouth and changing them every twelve hours; the latter much shorter ones, which (if not coughed up) may be left *in situ* for a fortnight, resting upon the ventricular bands without passing through. The shortest are an inch and a half in length; the longest three. At the upper end is a diamond-shaped head flattened in front and provided with a small eye to carry a thread. Below is a neck which expands into a fusiform enlargement. Each tube is provided with a jointed

guide, which can be screwed on to an introducer. This consists of a stem set on a handle and carrying a sliding tube, so arranged that when the cannula is in position it can be pushed off the guide and left as the latter is withdrawn. Finally, there is an extractor for the purpose of getting the cannula out again. The cannulæ and guides are made in five sizes, the smallest being suitable for a child under two years of age.

The child must be well wrapped up in a blanket and held by the nurse in a sitting position on her lap, so that the occiput rests against her left shoulder. The assistant stands behind and steadies the child's head. A suitable tube is selected, threaded with a long loop of silk, and fitted on a guide. This is then screwed on to the introducer and a gag placed in the mouth on the left side. The operator

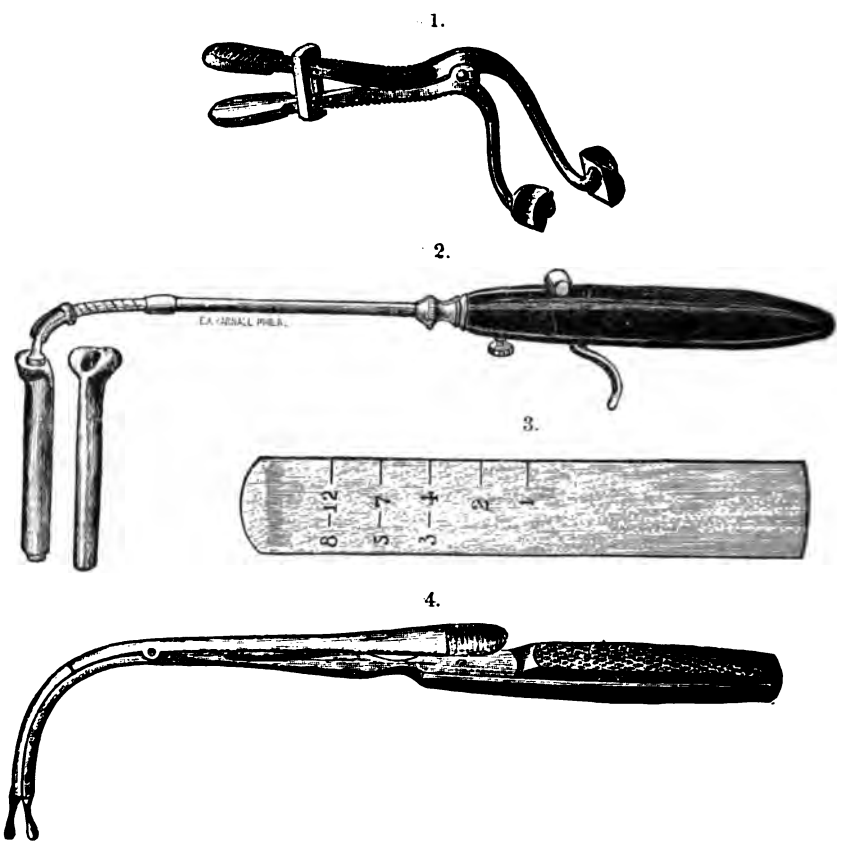


FIG. 356.—O'Dwyer's Tubes. 1. Mouth Gag. 2. Introducer. 3. Scale. 4. Extracter.

now hooks the loop attached to the tube round the little finger of his left hand, and passes the index finger over the tongue on to the epiglottis, following it up closely with the end of the tube in his right. Then he either simply hooks the epiglottis forward, and slips the tube over it, when, if suddenly turned down and kept in the middle line, it must pass into the larynx; or he passes over it on to the arytenoid cartilages and guides the cannula in. In either case it must follow the palmar surface and glide in under the tip. The moment it is in position, the sliding tube should be shot forward, the guide drawn back, and the cannula pushed on with the finger. The object of the loop of silk is to withdraw it, should it have missed the proper opening or passed into the pharynx.

The immediate effect is a violent fit of coughing, during which a large amount

of ropy mucus is expectorated. As soon as this ceases the loop may be cut, the silk drawn out (taking care not to displace anything), and the tube left.

Extraction is more difficult and may require an anæsthetic. The forceps are introduced closed, and the jaws separated from each other by touching a lever. The serrations are on the outer surface, so that there is no difficulty in holding the tube if it is once grasped.

In America intubation has apparently met with great success; those who advocate it affirm that there is no shock of hemorrhage, and that the relief is complete. In England, so far, very few cases are on record, and its merits in different diseases are not accurately known. In acute œdematous laryngitis, whether arising from scald of the glottis or other causes, it is probably preferable to tracheotomy; and after tracheotomy, when the tube cannot be dispensed with, a laryngeal cannula has on several occasions been used with advantage; but whether it can take the place of tracheotomy in diphtheria is very doubtful.

The operation is certainly not so easy; in practiced hands the introduction or removal of a laryngeal cannula may not be of much moment, even under circumstances such as these; but it would be almost impossible to those who have not had recent experience in manipulation. The larynx itself seems to tolerate the tube very well; they have been worn a fortnight without any ill consequence; nor is there any tendency for them to slip down, though they are often coughed up. It is a distinct drawback that they cannot be replaced by a nurse. It is said that the discharge from the trachea is freely coughed up through them, in spite of their narrow calibre. On the other hand, feeding a child is very difficult: An œsophageal tube may be tried, or the patient may be laid upon his back with the head hanging well down (so that everything falls of its own weight over the upper aperture of the larynx); but neither of these proceedings is easy, and in a large proportion of cases fluids find their way down by the side of the cannula into the lungs and set up broncho-pneumonia. Moreover, there is great risk that the cannula may force down some membrane in front of it, and block the trachea at once; and this is so important that even those who recommend intubation advise that the tracheotomy instruments should be immediately at hand. If intubation is to be employed in cases in which parents refuse their consent to tracheotomy, this is a matter of serious moment. Finally, it does not allow the trachea or larynx to be cleared in any way except by the natural efforts at expulsion through the narrowed opening.

## Excision of the Larynx.

Excision of the larynx may be complete or partial. The former implies the removal of the whole of the cartilages, with sometimes part of the trachea, pharynx, hyoid bone, and circumjacent structures, and with rare exceptions is the only measure that can be adopted in the case of malignant growths of extrinsic origin. The latter aims merely at removing the seat of disease, and is only applicable to intrinsic tumors, that is to say, those springing from the vocal cords, true or false, and the parts immediately around them.

Excision has been performed for obstinately recurring and extensive papillomata, for lupus, perichondritis, and even for stenosis; but with very few exceptions, too few to take into consideration, it is never called for except in the case of malignant disease. In sarcoma it has proved fairly successful; in epithelioma, on the other hand, total extirpation is exceedingly fatal, in great measure from the direct effect of the operation. Partial excision, however, shows a much better result, and it seems probable, as the importance of the early diagnosis and early removal of carcinoma is more widely recognized, it will become better still. In other words, in extrinsic malignant disease, with very few exceptions, only palliative measures are advisable; and the same must be said of those cases of intrinsic disease in which the growth has advanced so far as to render complete extirpation

# CHAPTER XV.

## *DISEASES OF THE THYROID.*

The thyroid gland consists of a number of separate sacs lined with a single layer of nucleated cubical cells, and surrounded by exceedingly vascular adenoid tissue. Colloid degeneration, affecting the contents of the sacs and attended with atrophy of the cellular lining, is of such common occurrence as almost to be considered normal. Nothing is known with regard to its function, beyond the general fact that the activity of growth and nutrition of all parts of the body (including the brain) is intimately connected with its integrity. In women it frequently enlarges and becomes tender—at puberty, during the menstrual period, and during pregnancy. Cretinism is, in all probability, due to its imperfect development; removal during childhood causes a similar condition, and, in a large proportion of cases, removal of the whole gland is followed by myxœdema, if performed on adults. The temperature falls; the oxygenating capacity of the blood diminishes; leucocytosis sets in; the coagulability is lessened; the skin and subcutaneous tissue undergo a peculiar transformation; nervous symptoms (tremors, paresis, paræsthesia, etc.) make their appearance, and, at length, a cretinoid condition, with imbecility and coma, follows. When this does not take place, it is probably owing to the fact that the whole gland has not been removed, or that accessory thyroids (which are of very common occurrence) have undergone compensative hypertrophy. Sometimes it follows with great rapidity shortly after the operation; sometimes, on the other hand, slowly and gradually. In a few instances the immediate onset, after a period of apparently perfect health, has been brought on by exposure to cold.

### Inflammation of the Thyroid.

Inflammation may be acute or chronic, and in resolution or in suppuration and sloughing, according to the cause and the addition or not of pyogenic irritants.

The symptoms, when the attack is acute, are very alarming, often beginning with a rigor and high fever. Owing to the way in which the gland is bound down by the cervical fascia, the pain is very severe; the tissues of the neck are hard and rigid, the superficial veins distended, the trachea and œsophagus compressed against the spine, and even cerebral symptoms caused by the obstruction to the cranial circulation. In most cases resolution sets in after forty-eight hours, and the acute symptoms begin to subside, but often the improvement is only partial; the diffuse enlargement disappears, but one or more local swellings remain; the skin becomes red and œdematous, and at length fluctuation is apparent. Death may occur from pressure upon the trachea, from pus finding its way down into the lungs, or from pyæmia or septicæmia. In one or two instances the gland has sloughed.

The treatment must be energetic. At the first onset aconite or antimony may be given internally in small, frequently repeated doses, until a distinct effect is produced upon the arterial tension. Ice-cold compresses should be placed upon the neck, the superficial veins pricked to relieve the circulation, and leeches applied to the supra-clavicular region. Venesection (either from the arm or the external jugular) may be advisable, if the patient is young and the inflammation sthenic. If signs of suppuration make their appearance, the superficial structures must be carefully divided, layer by layer, and a director used for exploration after Hilton's method. A drainage tube must be inserted to prevent the opening becoming valvular.

### Simple Enlargement, or Goitre.

All forms of enlargement of the thyroid that are not the result of inflammation or malignant disease are grouped together as *goitre*. The blood-vessels only may be affected, and the change limited to the gland (*pulsating bronchocele*); or this may be associated with other symptoms referable to the vascular system (*exophthalmic goitre*, or Graves' disease). The vesicles or the interstitial connective tissue, or both together, may be hypertrophied without any change in structure and without any considerable alteration in proportion (*parenchymatous* or *follicular enlargement*). This may be complicated by various forms of degeneration. The follicles may enlarge into colloid cysts, while the interstitial tissue atrophies and wastes until neighboring cavities fuse together and form huge, irregular spaces (*cystic goitre*). Sometimes the contents remain clear and gelatinous; sometimes they become blood-stained and mixed with debris from the walls and vessels, until scarcely a trace of the original character is left. In many cases proliferating villous growths, consisting almost entirely of blood-vessels with a thin layer of epithelium over them, make their appearance, springing from the inner wall of the vesicles, and filling them with a soft, almost erectile mass. In others the fibrous tissue is the part chiefly affected; diffuse or localized bands are developed in all directions among the vesicles, and grow larger and harder until the whole structure becomes solid (*fibrous goitre*). Finally, in most, the degeneration is not limited to any one tissue, but involves them all in varying proportion, so that masses of soft, vascular, interstitial substance, vesicles, cysts with all kinds of contents, and dense fibrous tissue are mixed up together, and rendered still more complex by calcareous degeneration of the walls and capsule.

An attempt has been made to distinguish simple hypertrophy from adenoma, reserving the latter for those cases in which there are either distinct separate tumors or isolated portions growing out in an atypical form; but it is very doubtful if this can be maintained. A few cases are recorded in which secondary growths, pulsating and resembling the normal thyroid in structure, have occurred in the bones of the skull and other parts of the body. In some of these an apparently simple goitre was present; but, in others, there was scarcely any increase in size.

**Symptoms.**—These depend upon the nature and rapidity of the enlargement. Certain features are, however, common to all alike.

The swelling may involve the whole gland and accurately follow its shape, or it may be confined to one side, or to the isthmus; but, whatever part it involves, it always moves up and down with the larynx in swallowing. This is due to the arrangement of the cervical fascia, and is the distinctive feature of thyroid tumors. They may be smooth and uniform in outline, or covered with irregular bosses, or pedunculated and hanging by a stalk over the sternum. Sometimes the enlargement consists almost entirely of vessels or of cysts filled with masses of vascular outgrowths, so that the swelling is soft and elastic, and pulsates almost like an aneurysm, with, in many cases, a thrill. Sometimes, on the other hand, only the fibrous tissue is concerned, and the tumor is nodular, dense, and firm.

Other symptoms are due to pressure. Large, slowly-growing tumors, that project in front and become pedunculated, do not offend in this way. Small ones, on the other hand, that lie in the isthmus or extend around the trachea between it and the œsophagus, and dense nodules that are sometimes scarcely apparent on the surface, are often much more serious, especially if their growth is rapid. The trachea may be flattened, bent, or displaced to one side of the neck. The cartilages may be absorbed, the recurrent laryngeal nerve paralyzed, the movement of the œsophagus interfered with, and the great vessels and nerves stretched or flattened. Sometimes goitrous thyroids suddenly enlarge; they are exceedingly vascular, and excitement or violent exertion may lead to such intense congestion as to cause instant death.

Acute goitre is very rare in England, although it is described as occurring in an epidemic form among troops in France. There is a certain amount of evidence

connecting it with the rheumatic diathesis, but the cause is as obscure as that of the common variety. The swelling is rapid and painful, the neck cannot be bent, the skin is tense and white; usually there is considerable dyspnœa with hoarseness, and sometimes a rather high degree of fever. It has been suggested, on the analogy of mumps, that it is really a form of specific inflammation, but it has not been shown to be contagious.

The hyperæmia that occurs during the menstrual period and at pregnancy is usually transient, and merely causes a feeling of fullness and tenderness in the neck. In a few cases, however, the swelling never subsides completely, and it may be followed by fibro-cystic degeneration.

Pulsating bronchocele may occur as part of Graves' disease or independently. In the former case the whole gland is uniformly enlarged, all the blood-vessels are

Fig. 358.—Parenchymatous Enlargement of the Thyroid.

dilated, the pulsation is equally marked over the whole surface, and the solid tissues do not hypertrophy until the disease has lasted some time. In addition, the enlargement of the gland is associated with other symptoms which have been assigned (although on very inadequate evidence) to a lesion of the sympathetic. In the latter case the primary affection appears to be the development of exceedingly vascular intra-cystic growths, although, of course, the blood supply of the whole gland is increased as well. The surface is covered with bosses, some of which pulsate so strongly that they may be mistaken for aneurysmal dilatation of the carotid or subclavian, and the amount of stroma and solid tissue is considerably and irregularly increased. Many of the cysts are filled with broken-down blood-clot and tissue debris, and the changes these undergo in course of time add considerably to the varied character of the morbid appearance. Disease of this kind

may remain unchanged for years, sometimes growing larger—when the patient is out of health—and then again diminishing, without apparently producing any constitutional effect. In one or two cases, however, secondary deposits of a similar character have made their appearance in distant parts of the body, as if the primary growth had in some way infected the blood stream.

Fibroid and fibro-cystic goitres may attain an immense size. Generally one element is very greatly in excess of the other, but they rarely occur entirely by themselves. The shape and density of the swelling, and the symptoms it causes by pressing upon neighboring organs, naturally differ according to its character and direction.

**Diagnosis.**—All thyroid swellings move up and down with the larynx in swallowing. Accessory thyroids (which sometimes undergo a similar transforma-

FIG. 359.—Cystic Bronchocele.

tion and develop into gigantic tumors) present the greatest difficulty. They may occur in any part of the neck, naturally most often in front, but sometimes under the mucous membrane of the trachea or larynx, or below the upper border of the sternum. Bursal cysts develop in connection with the thyro-hyoid space; congenital cysts and such rare tumors as tracheoceles, can hardly be mistaken.

**Treatment.**—A very great deal may be done for recent parenchymatous goitres and for some forms of pulsating bronchocele. Even when fibroid or cystic degeneration has set in, the size of the swelling can be considerably reduced, but the prospect of perfect resolution is not nearly so good. Graves' disease, in which the affection of the thyroid occurs as part of a general disorder, stands on a different basis.

Nothing is of much use so long as the patient lives in a goitrous district.

ulation as far as possible. The syringe is then withdrawn, the cannula ed and left *in situ* for about three days. At the end of that time the contents lowed to escape, and if they are thin and serous, or if there is much blood n other words, suppuration does not appear probable—a second injection is

Poultices are applied to encourage this, and the cannula is retained as a ge tube until there is no longer any fear of the opening becoming valvular. lan is not devoid of risk by any means; suppuration may be acute with high and, although it is usually successful, the inflammation may cause serious ings for a time.

ectrolysis has been used with considerable success in vascular goitre, even ere were definite exophthalmic symptoms. Duncan recommends a current 40 to 80 milliampères, and relies chiefly upon the destructive action egative pole, moving it about freely from side to side as soon as it has d a decided effect.

der certain circumstances operative treatment becomes imperative. The may be compressed or distorted, causing marked tracheal stridor and on the least exertion. The recurrent laryngeal nerve may be irritated or ; if this occurs on both sides the condition at once becomes very critical.

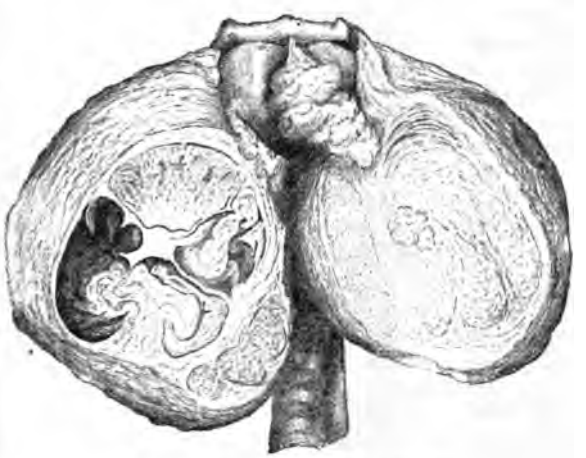

FIG. 361.—Cystic Degeneration of Thyroid.

h may extend downward between the trachea and the sternum, or rachea, or grow backward against it so as to compress it; or there already an attack of suffocative dyspnœa due to sudden enlargement

ice lies between tracheotomy, division of the isthmus, enucleation of nd ligature of the arteries supplying the gland.

omy, of course, is only palliative, it may be necessary on the spur t, a special tube, or, if this is not at hand, a gum-elastic catheter, down the trachea through the constricted part. The difficulty of tion can hardly be exaggerated; low tracheotomy is, of course, out on—even the upper part of the trachea may be concealed or pushed or flattened, so that it presents a sharp edge, or so covered with ls and portions of the growth as to be almost inaccessible. Bose's sverse division of the cervical fascia, and pulling all the structures downward from off the front of the trachea) may be the only one

of the isthmus, on the other hand, is exceedingly successful, and, in tion of cases, has been followed by the unexpected diminution in

...me extent this may be due to the recession ... will not account for the whole. The ... the skin and superficial fascia are divided; ...-hyoid and sterno-thyroid muscles (which are ... that lie on the front carefully detached, ... trachea by means of the finger and a director. ... round the isthmus and the intervening tissue ... simply be divided, and allowed to retract. This ... exophthalmic goitre, for the relief of the ... considerably reduced in size before the patient ... several symptoms.

... laid down for enucleation: it may be practised ... adenomatous growths, and sometimes considered ... this way (the part left undergoes hypertrophy). ... free from the risk of myxœdema, unless the amount ... the greatest care is necessary if the growth lies near ... geal nerves. On several occasions one has been ... their function has been seriously impaired by the ...

... arteries has been tried; but, at the best, it can only ... has not been sufficiently good to justify the risk.

### ... Disease of the Thyroid Gland.

... are both known to occur, but they are not common ... round-celled or spindle-celled, and may be recognised ... growth, and (when the cervical fascia has yielded before ... persistence. The latter is stated to be either encephaloid ... occur until late adult life, and usually as a complication ... suddenly beginning to enlarge and become painful. The ... are until the lymphatic glands or the neighboring tissues ... out of the question. It is probable that the second ... similar in structure to a cystic proliferating thyroid, and ... parts of the body, are really carcinomatous.

# CHAPTER XVI.

## *INJURIES AND DISEASES OF THE PHARYNX AND ŒSOPHAGUS.*

### MALFORMATIONS.

Congenital occlusion of the pharynx is due to the invagination that forms the mouth failing to open into the anterior end of the primitive intestine. In congenital stricture the defect is the same, but less marked.

Diverticula may originate in the same way. Some of these are acquired (pharyngoceles): a part of the wall is weakened by inflammation or injury to such an extent that the mucous membrane bulges out through the opening; the larger ones, however, and especially those that occur in the region of the inferior constrictor, are congenital in origin. When small they are not noticed; as they increase in size they form a pear-shaped swelling by the side of the neck, pressing upon the great vessels, displacing the larynx, and often causing dyspnœa and violent fits of spasmodic coughing from pressure upon the superior laryngeal nerve. The nature of the sac is easily recognized from the variations in its size at different times, and from the way in which its contents (air and sodden food) are returned into the mouth when it is subjected to external pressure, or squeezed by the muscles around it. As it enlarges it displaces the œsophagus, becoming more vertical and drawing nearer the middle line, until the natural passage is thrust entirely out of its axis. In one of these cases Wheeler laid open the tumor from the outside, excised it, and successfully secured the margins of the opening with catgut sutures.

Congenital dilatation of the œsophagus has also been described as affecting its whole length, but this is still more rare. A minor degree of the same disorder sometimes results from fatty degeneration of the muscular wall. As a rule, hypertrophy and narrowing occur above a stricture.

### INJURIES OF THE ŒSOPHAGUS.

The œsophagus may be wounded from the outside in cases of cut-throat, or from inside by corrosive fluids or hard and sharp-pointed foreign bodies. In rare instances rupture has taken place during vomiting, but probably only when the walls have been weakened beforehand by inflammation or fatty degeneration.

Swallowing corrosive fluids is nearly always done with suicidal intent, the liquid (usually a mineral acid or a very strong alkali) being thrown quite to the back of the pharynx, so that the lips, mouth, and tongue are often not touched. [I have seen some cases where children produced œsophageal stricture by the swallowing of "Concentrated Lye."] The immediate effect is profound collapse with intense burning pain, followed by vomiting of mucus, blood, and sloughing shreds of epithelium, mixed with the contents of the stomach. If the result is not immediately fatal from perforation or collapse, the severity of the symptoms gradually subsides; there is less blood and more mucus and pus in the fluid that is brought up; the pain becomes less severe; the swelling and thickening around the œsophagus diminish, and the febrile symptoms abate. Swallowing, however, causes very great pain, and if more than the epithelial surface has been destroyed, it rapidly becomes more and more difficult, until at length a traumatic stricture is established. The wall of the œsophagus contracts spasmodically on the irritant before it is vomited back, and thus it may happen that the whole of the tube, from the cricoid almost down to the cardiac orifice, is more or less eaten away. In cases of long standing the walls become enormously thickened from inflamma-

means of dilute acids. Irregular structures, such as false teeth, may be laid hold of by what is known as a coin-catcher (Fig. 363), a blunt, flat hook attached to a probang by a thin strip of steel, so that it can glide past an obstacle and then catch against it as it is withdrawn ; and considerable force may be used. If this fails, and if the foreign body is impacted in an accessible part of the œsophagus, it must be removed by operation.

Unless there is some special reason—such, for example, as the projection of the foreign body distinctly to be felt—œsophagotomy is always performed on the left side. The head is turned in the opposite direction and an incision three inches long is made at the inner margin of the sterno-mastoid. The superficial structures are divided, the deep fascia slit up on a director, and the muscle pulled well toward the outer side, so as to expose the sheath of the great vessels. The dissection is then carried carefully between this and the trachea, avoiding the thyroid arteries and veins, the thyroid gland, and the inferior laryngeal nerve, until the œsophagus and the lower part of the pharynx are exposed. If the omo-hyoid muscle gets in the way it may be divided, and any veins that cannot be drawn to one side must be secured either by ligature or by pressure forceps, so as not to obscure the deeper parts. Generally a sufficient surface can be brought into view by pulling the trachea one way and the great vessels and the sterno-mastoid the other ; but sometimes part of the sterno-hyoid or sterno-thyroid requires division. If the foreign body can be felt from the outside, a longitudinal incision may be made over it and the finger introduced so as to ascertain its position more accurately. If this cannot be done, a sound is passed through the mouth and made to project into the wound. Afterwards the opening may be enlarged to a sufficient extent, and the foreign body withdrawn with appropriate forceps. If the impaction is recent and the wound in the œsophagus not bruised, the edges may be sewn together with catgut, the sutures being inserted only in the muscular wall, leaving the mucous membrane untouched. Under other circumstances it is better to leave the whole open, with a large drainage-tube in the superficial wound. For the first few days the patient should be fed with nutrient enemata only ; afterward an œsophageal tube may be used until the wound is sound. The thirst can be relieved, as Southam suggests, by allowing the patient to drink a boracic acid mixture (gr. x ad ℥j). Most of it flows out through the wound (if it is not sutured), and helps to keep it clean. A fistulous opening often persists for a time, but in most cases it closes without requiring anything further.

When the foreign body is low down the question is more difficult. Southam performed œsophagotomy successfully in a case in which a plate of false teeth was impacted three inches below the upper border of the sternum. In other cases the stomach has been opened and the foreign body dragged onward or pushed back, as seemed best at the time.

Gastrotomy may be required if it has passed the œsophagus and is lodged in the stomach. Sometimes the foreign body can be felt through the wall of the abdomen ; if this is impossible its presence can usually be ascertained with a suitable probang. In most cases, however, if it has once reached the stomach it is able to pass on through the pyloric valve without further trouble, although it may lodge again just above the external sphincter. Purgatives should never be given ; vegetable [such as mashed potatoes] and farinaceous diet is the best, owing to its bulky character.

### Diseases of the Œsophagus.

*Inflammation* of the mucous membrane may arise from injury (as already mentioned) or from specific causes, such as tubercle, syphilis, thrush, or diphtheria ; but, with the exception of the first of these, the symptoms are vague, consisting merely of pain in swallowing, and rarely attract attention unless the ulceration is so extensive as to lead to the formation of a cicatricial stricture.

*Paralysis* of the muscular coat of the pharynx or œsophagus is occasionally met with after diphtheria, and may in rare instances be due to alcoholic or lead

poisoning. Dysphagia is always present, but it differs from that which occurs stricture, in that solids are swallowed more easily than fluids. Sometimes food collects and is ejected after a time by coughing or vomiting.

*Hysterical paralysis* is much more common, the patient being convi either that there is a foreign body in the œsophagus, or that there is a stric (usually after having seen a case), and being unable to will the act of deglutit It is chiefly met with in young women who present other hysterical sympt but it may occur in men. The suddenness and incongruous nature of the s toms, the history and a few days' careful watching, are sufficient to prev mistake. The greatest difficulty is in connection with foreign bodies; a fish- perhaps has been actually swallowed and scratched the mucous surface; and sensation arising from this, and intensified whenever anything passes down sufficient stimulus to keep up the suggestion of dysphagia in the patient's h It rarely happens, however, that there is any collection of food above the obs tion; either the patient keeps it in the mouth without attempting to swall or, if it does pass over the larynx, it is immediately ejected again, often wi unnecessary display of energy.

Closely akin to this, and occurring under the same conditions, is a fo muscular spasm which affects the pharynx rather than the œsophagus. It v from merely a slight stammering of deglutition, such as might arise from s nervousness, to violent ejection of the contents of the pharynx through the m and nose. In neither of these conditions, however, whether paralysis or spa the prominent feature, is there marked emaciation or craving for food; the pa is usually fairly well nourished, though always complaining (differing in respect altogether from those who persistently refuse to take any food), and unfrequently it is found, on making inquiry, that it has already lasted many off and on, long enough to negative absolutely organic contraction.

Many of these cases are cured at once by faradization or the passage bougie, but unless the morbid state of the nervous system is in some way rel or the exciting cause of the hysteria removed, they nearly always relapse.

### Tumors of the Œsophagus.

With very few exceptions, the only form of new growth that occurs œsophagus is squamous epithelioma. It is chiefly met with in men, very under forty years of age, and forms an annular and rapidly contracting str The surface ulcerates away, but, as in the intestine, the infiltration into the mucous, and later into the muscular coats, increases so fast and contracts so that the calibre very quickly becomes narrowed. Later it involves the tissues and the other structures around (the trachea for example), spreadin them by direct extension, and, if it does not prove fatal fom starvation or monia, forms secondary deposits in the glands and elsewhere.

The seat of election is behind the carotid cartilage or where the left bro forms a ridge in the mucous membrane—the places, in other words, in whi calibre is smallest and the walls most rigid. No part, however, is exempt.

The chief, and for some time the only symptom of which the patient plains, is the rapidly increasing difficulty in swallowing, first for solids and for liquids. Emaciation speedily follows, but fortunately the sense of h especially in the later stages, is seldom very distressing. Vomiting may the saliva, with a certain amount of mucus, particles of food, and some little blood, collecting on the face of the stricture. Pain is rarely severe, alth particularly when the tissues around the œsophagus are infiltrated, atten swallowing or passing a bougie cause great discomfort. No external tumor felt, with rare exceptions, and often there is no distinct glandular enlar

## Stricture of the Œsophagus.

Organic stricture may be congenital or acquired. The former is exceedingly ; the latter, which is very common, may be simple or malignant.

Simple stricture arises nearly always from the swallowing of corrosive fluids. mucous membrane sloughs and cicatricial contraction follows. Sometimes ıst the whole length is obliterated in this way, but the effect is always greatest ıe commencement. In very rare instances it may arise from some form of ific inflammation, such as tubercle or syphilis.

Malignant stricture is always the result of squamous epithelioma, and is usually ılar, the muscular coat above being considerably hypertrophied.

**Symptoms and Diagnosis.**—Pain and difficulty in swallowing are the ıinent symptoms. The former is exceedingly severe at the beginning in cases ıaumatic stricture (in great measure owing to the inflammation around the )hagus), and gradually becomes less as the cicatricial tissue becomes firmer. latter is usually the only thing of which a patient complains when it is due )ithelioma. It may come on comparatively suddenly, an unobservant person ıoticing any difficulty until the narrow channel is blocked by the impaction of ger or harder fragment than usual, or, more frequently, it is gradual from the solids causing difficulty before there is the least obstruction to the passage of ds. In a few instances deglutition is rendered almost impos- by fits of spasmodic coughing.

The diagnosis can only be made certain by the passage of a ;ie ; but, as dysphagia occurs in other affections in which a eeding of this kind is not unattended with danger, an attempt t always be made to exclude them first.

(*a*) *Muscular spasm or paralysis* may simulate true stricture. re may even be a history of some foreign body having been llowed ; but it is never the kind that causes traumatic stricture. is there really any likelihood of mistaking spasmodic contrac- for malignant disease, for while the latter rarely occurs except en, and never under the age of forty, the former is almost con- ! to young women, and is always marked by the peculiar incon- y of its symptoms. In diphtheritic paralysis, which is very the food usually passes slowly down for some time before it ı, and solids are swallowed more easily than liquids.

Fig. 364. — Malignant Stricture of Œsophagus laid open.

(*b*) *Compression of the Œsophagus.*—Dysphagia arising from is exceedingly common, and although the cause is usually suffi- tly prominent, this is not always the case. Aneurysms of the a ; tumors of all kinds growing from the vertebræ, lymphatic ds, cellular tissue, or other structures near the œsophagus ; enlarged or ssory thyroids ; gummata (especially retro-pharyngeal) ; abscesses, connected ı the vertebræ or not, and other conditions, may give rise to it. Aneurysms ? been ruptured before now by the passage of a bougie, and that, too, without xcessive amount of force having been used.

(*c*) In a few cases *dysphagia* has been traced to the presence of a pharyngo- dragging the orifice of the œsophagus out of its true axis.

**The diagnosis** of simple from malignant stricture rarely gives rise to diffi- . Practically, unless there is a very clear history of a gumma or of tubercular se, a stricture that develops after the age of forty without injury is malig- .

If the presence of an external tumor pressing upon the œsophagus is negatived, ıgie must be passed, not only to verify the existence of a stricture, but to ascer- its locality, and, perhaps, its diameter. The patient should be seated on a ght-backed chair and the head supported by an assistant. It should rather ıade to poke forward than upward, in order to straighten out the cervical e ; if it is thrown back the bougie strikes against the bodies of the vertebræ.

A medium-sized gum-elastic one (equal to No. 24 or 27 catheter on the French scale) should be chosen to begin with, warmed by dipping in hot water, and well lubricated with glycerine. The point should be bent down a little. The operator then, standing in front of the patient, runs the forefinger of the left hand over the tongue, and guides the bougie, which is held in the right, over the base to the back of the throat. If protected like this, it cannot pass up into the naso-pharynx or enter the larynx. Nearly always it causes a certain amount of spasm as soon as it touches the mucous membrane, and when it comes near the cricoid it is not unfrequently gripped tightly and then forcibly ejected by retching, or suddenly pulled out by the patient. To some extent this can be prevented by a cocaine spray, or by brushing the surface of the mucous membrane over with a two per cent. solution, but nearly always, except in the case of very ignorant men, it can be overcome by patience, No force may be used under any circumstances; I have more than once known pneumonia develop suddenly after a bougie had been passed.

If the end is definitely arrested but not gripped, it must be withdrawn and a smaller one selected; in some cases only a catgut will pass. Measured on a bougie, the cricoid cartilage is approximately seven inches from the teeth, the left bronchus eleven, and the opening in the diaphragm fifteen.

Other methods of examining the œsophagus are of very little value. Auscultation (the stethoscope being placed by the side of the spine, while the patient drinks some water) may be tried, but it rarely gives any indication that can be interpreted. The condition of the lungs, especially the amount of bronchial irritation caused by the passage of a bougie, and the state of the cervical glands, whether enlarged or not, are very important factors in the prognosis.

The **treatment** of stricture of the œsophagus depends upon the cause, whether it is traumatic or cancerous. In the former case the walls are usually very much thickened (although it may be a long time before the sloughing in the interior ceases), the patient is often young, and there is no danger but that of starvation; in the latter, if the patient lives sufficiently long, ulceration always gains the upper hand and causes perforation, and even if starvation and pneumonia are successfully prevented, the result must inevitably prove fatal within a few months from the malignant cachexia.

(1) *Traumatic Stricture.*—In any case in which the interior of the œsophagus has been seriously injured, contraction must be prevented by the use of bougies. Treatment should commence as soon as the sloughs have separated and cicatrization is beginning, the greatest care, of course, being used. Special instruments with rubber tips, one or two inches in length, so as to ensure thorough flexibility, and about the size of a No. 24 or 27 catheter, are the most useful. At first they must be passed every day, then, if the tendency to contract is not very marked, at gradually increasing intervals; but, as it may be necessary to make use of them for the rest of life, the patient should learn as soon as possible how to pass them for himself. The food must, of course, be suitably prepared throughout.

In old cases, in which the stricture has been allowed to contract, the difficulty is very much greater. Gradual dilatation is the most successful method, using slightly conical instruments. It may be necessary to begin with catgut, if the constriction is very narrow, leaving it *in situ* for twenty-four hours, or making use of it as a guide on which a fine rubber tube can be slid down; the patient can always swallow liquids by the side of it. Internal œsophagotomy (division of the stricture from within) is a very risky operation, and as the stricture must be a permeable one to allow of its being done, can very seldom be advised. In exceptional instances an artificial opening has been made in the neck below the stricture (œsophagostomy), and the stomach has been opened and the stricture dilated through the cardiac orifice. Practically, if dilatation fails gastrostomy must be performed. The results, compared with those of the same operation for malignant disease, show a far higher percentage of success, but it is not probable unsuccessful cases have been published.

(2) *Malignant Stricture.*—Excision of the growth has been practiced with success, an artificial opening into the œsophagus being left at the root of the neck; but cases in which such a proceeding is possible are very seldom met with. As a rule, all that can be done is to make an artificial opening below the stricture, either in the œsophagus or stomach, or to maintain the patency of the canal by means of tubes or bougies.

(*a*) *Œsophagostomy.*—This can only be performed when it is certain that the growth is limited to the very commencement of the œsophagus—a condition practically impossible to prove. The incision is the same as for œsophagotomy, but lower down, and as the tube is collapsed and empty, covered with important vessels and in close relation with the pleura and thoracic duct, it is evidently more dangerous.

(*b*) *Gastrostomy.*—The results of gastrostomy for malignant disease of the œsophagus are exceedingly bad. It is true that they have improved to a certain extent in recent years, and that in all probability if the operation were performed earlier in the course of the complaint, before the patient was exhausted by starvation and the growth of the malignant disease, they would improve much more. But it must be remembered that gastrostomy is only a palliative, not a radical operation; it does not pretend to cure the patient, but only to relieve him, and that, therefore, if the same results can be obtained in other ways, it is not justifiable to run the risk. Symonds has divided the course of the disease into two periods: before and after the signs of bronchial irritation have set in. Of these the symptoms that occur in the former can be relieved as well by tubage (in all ordinary cases) as by gastrostomy; for those of the latter neither is of any real avail. If ulceration has once opened up a communication between the œsophagus and the bronchi, or trachea, food can be prevented from passing down into the lungs, but nothing can prevent the entry of mucus, saliva, blood, and particles of the growth detached by ulceration, and these will inevitably cause a speedily fatal broncho-pneumonia. In a few exceptional cases gastrostomy may still be necessary, and then it should be performed as early as possible, while the patient still retains his strength; but it rests with those who advocate it to show that the immediate dangers attending tubage are more serious than those of gastrostomy, or that tubage tends to make the progress of the disease more rapid by irritating the growth.

(*c*) *Tubage.*—Symonds' tubes are from four to six inches in length, and are made of gum-elastic upon a silk web, the outside and inside being as smooth as possible. The upper end is funnel-shaped so as to rest upon the face of the stricture and slightly flattened on one side that it may not press unduly against the back of the cricoid, and the margin is perforated in two places for the attachment of a silk thread. The other end is hollow, with a lateral opening. The tube can be introduced upon a bougie, but it is more easily managed with a proper whalebone guide set in a suitable handle. The exact site of the stricture is ascertained first and marked upon the guide; the greatest gentleness must be used, and as soon as the point enters the narrowed part the tube is slowly pushed onward until the resistance to the funnel is felt; the guide is then withdrawn, and the silk thread attached to the tube tied round the ear or fastened with strapping.

A tube of this kind can be left for two or three months without being changed, the patient swallowing liquid food through it. As a rule, however, it is necessary to remove the first after three or four days, as the stricture always dilates to some extent, and sometimes this must be repeated. Even if it sh uld slip through, it will pass *per anum* or remain lodged in the stomach withoo inconvenience.

Compared with gastrostomy this method possesses very great advantages. There is little risk to life; the presence of the tube does not appear to increase the rapidity of the ulceration, although in one or two instances, it is said to have caused circumœsophageal suppuration; the discomfort is not greater, if so great, as it amount of food can be taken quite as easily. In either case the

end is the same; as soon as bronchial irritability becomes a prominent feature, soon as the ulceration extends into the air passages, debris, mucus, and fore matter of all kinds will make their way into the lungs and set up broncho-pn monia (all the more rapidly because of the malignant disease), whether a st tube is worn or gastrostomy has been performed.

When this final stage is reached the only course left is the introduction o long tube made of thin rubber, so as to exclude, as far as possible, all fluid fi the œsophagus. Krishaber's are too hard, and very soon cause ulceration at back of the larynx from the constant friction. Soft red rubber ones may, howe be used for a considerable time. In ordinary cases, in which the malignant gro is situated high up, life may be prolonged in this way for a further period; when the disease is opposite the left bronchus, the thin partition very soon ul ates through, pneumonia is sure to follow, and even gangrene of the lung r occur.

# CHAPTER XVII.

## *INJURIES AND DISEASES OF THE CHEST.*

## INJURIES OF THE CHEST.

Fractures and dislocations of the ribs or sternum, contusions of the wall of the thorax, and wounds involving the nerves, muscles, or vessels, may occur with or without injury to the subjacent viscera. In some cases it can be seen at once whether they have escaped or not; in others, it is a matter of the greatest difficulty; but, if there is the least doubt, the case should be treated as if the graver injury were proved, and no attempt must ever be made, by probing or otherwise, to determine one way or the other. The finger may be used to explore for foreign bodies, or to ascertain the depth and extent of a penetrated wound, not to find out whether it penetrates or not.

### Injuries of the Wall of the Thorax.

Contusions are very common, and are rarely attended by serious consequences. The shock, however, may be severe (it is said to have proved fatal by itself, without visible injury of any kind), and the extravasation, when it takes place in the deep planes of loose cellular tissue beneath the muscles, is sometimes very extensive, and is likely to be followed by suppuration. In many cases the muscles are badly bruised; occasionally they are torn as well, especially the pectoralis major, which may be pulled in two by a sudden catch at something as the body is falling. When this occurs the signs are very definite; a great gap appears at once, involving particularly the sternal part of the muscle; there is very extensive hemorrhage, and, when this subsides, the torn ends retract as far as they can, and waste away. Nothing can be done for it when the muscles and fascia are torn completely through, but, if the injury is not quite so severe, a fibrous cicatrix forms and ties the ends down to the wall of the thorax, so as to make a new attachment.

The deeper structures do not always escape when the external injury is apparently slight; the pleura may be bruised and become inflamed; there may be a contusion of the lung with hemorrhage into the substance, causing pneumonia and even traumatic gangrene; or, without the pulmonary pleura being torn, the air vesicles may be ruptured, and the air forced into the cellular tissue of the lung until it appears at the root of the neck (*interstitial emphysema*); and in young patients particularly, when the ribs are still elastic, and the wall of the chest can yield without breaking, the lung and pleura may be lacerated, so as to cause pneumothorax or hæmothorax, without there being external injury of any kind; even the pericardium and the heart may be crushed and torn.

### *Fracture of the Ribs.*

The ribs may be broken by direct or by indirect violence. In the former case the position of the fracture depends upon the force, and the fragments are driven inward, for the moment at any rate. In the latter, if the chest is compressed from before backward, they generally give way at the widest part of their curve—in the axillary line—and the ends are forced outward, so that there is less risk of the lung being wounded; but this is very far from invariable. In rare cases the fracture results from muscular action.

The first rib can only be broken by direct force, and then it is scarcely possible unless the clavicle gives way as well. The last two escape, from their small

on one side only, great relief is given by restricting the movement of The patient must empty his chest as far as possible, and then strips must be placed round it from the spine to the sternum, commencing arranging them so that each covers at least half the preceding one. may be placed a flannel roller, which is prevented from slipping down of a brace over the shoulders. When, however, several are broken, if they are on both sides, compression is not unlikely to increase the liscomfort. In this case a sheet of gutta-percha may be carefully moulded s, or the patient may simply be placed in bed, propped up with a bed- at the breathing shall be interfered with as little as possible, and kept quiet. In severe cases this plan should always be adopted. Nothing lone to remedy displacement. The air in the uld be kept warm and moist, so as not to cause tion; the diet should be light and the bowels n; stimulants are rarely required. If there is h expectoration, but merely constant irritation ing, small doses of compound tincture of camphor lorodyne may be given; but when the respiration lt and embarrassed from the amount of expectora- ium is better withheld, and replaced by iodide of carbonate of ammonia, and stimulating expecto-

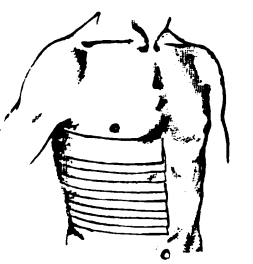

Fig. 366.—Strapping in Fracture of Ribs.

the dyspnœa is very severe, and cyanosis setting it is evident from the frothy, blood-stained sputa e presence of moist râles, etc., over the chest, that lmonary congestion is becoming severe, and if the pulse is hard and rapid, should be no hesitation in having recourse to venesection, though this is often required when the lungs themselves are injured. [In case of exten- mphysema, incision at the points of fracture and in various places through istended skin may be tried.]

### *Injuries of the Sternum.*

The sternum may be broken by direct violence, as in gunshot injuries; by rect, as in extreme flexion of the spine, when the chin is driven down on to manubrium, and the vertebræ dislocated; or by muscular action combined over-extension of the back, as in parturition, when the two ends seem literally e pulled asunder. In the first case the fracture may be transverse, longitu- al, or comminuted, according to the kind and direction of the force; in the latter the line of separation is usually transverse, and lies near the junction the manubrium with the gladiolus, and there may be either dislocation or frac- e. If there is a well-developed joint between the two portions, with a soft ntral space, almost arthrodial, the former will occur; if the two are firmly ited, the separation may take place above or below. The displacement is nearly ays the same, the lower fragment carried in front of the upper.

The **diagnosis** as a rule is easy, owing to the marked character of the de- rmity. Reduction can sometimes be effected at once; more often it is a matter very great difficulty and sometimes quite impossible; and it very rarely hap- ens, when the fragments have been restored to their normal relation, that they an be prevented from slipping back again. The prognosis, so far as the fracture concerned, is good; but the shock is often extreme, and laceration of the leura or pericardium, rupture of the internal mammary vessels, compression of the heart, and other grave complications, are not unfrequently present.

### *Non-penetrating Wounds.*

*Non-penetrating wounds* are rarely serious. If the muscles are divided, or if uch as the subscapular, is torn across, there may be free hemor-

rhage for a time, but it is easily checked. Sometimes, however, in punctured wounds a large hæmatoma forms in the loose cellular tissue under the scapula and proves dangerous from inflammation, and the same thing may occur with lacerated and gunshot wounds, which often, owing to the resistance of the ribs and the yielding character of the tissues that cover them, extend much further than is at first sight apparent.

The greatest care must be taken not to convert them by needless examination into penetrating ones. In most cases the question can be settled without touching the wound, its extent and the character of the weapon making it certain at once; but sometimes the diagnosis is difficult, and I have known a considerable degree of emphysema caused by injuries which certainly did not penetrate, where, for instance, the spike of some iron railings ran obliquely upward beneath a boy's scapula. Foreign bodies must be removed, even if they are fixed in the ribs, and the bleeding stopped as soon as possible. If the muscles are divided, catgut sutures may be passed through the fascia investing them, in the hope of drawing them together, and the greatest attention must be paid to position, so that there may be no strain upon them; but usually they unite either to the skin or to the tissue beneath. Drainage is very important, especially where the deep planes of cellular tissue are opened up; and the chest should either be strapped or fixed as far as possible, or, owing to the want of rest and the constant movement of the ribs in respiration, union is very likely to be delayed.

## Injuries of the Thoracic Viscera.

### *Rupture of the Pleura.*

Rupture of the costal pleura by itself probably occurs in every case of fractured rib or severe contusion of the thorax, but owing to the skin being unbroken the injury is repaired at once, with only a transient or local pleurisy at the most; and though such complications as hæmothorax from rupture of an intercostal or internal mammary artery and pneumocele may occur, they are very rare. When there is an external wound the pleura alone may be injured, without the lung, if the weapon is blunt and enters the thorax slowly, so that it pushes the lung in front of it, or if the wound is in the tenth or eleventh interspace; for though the pleura usually extends as low as the last rib, the lung, unless it is emphysematous, only reaches the tenth. In this case, however, the diaphragm and the subjacent viscera are very likely to suffer.

Other complications depend upon the size and extent of the wound. If it is merely a puncture or a small incision the diagnosis is often never made; but if it is extensive the lung may protrude without injury through the opening (*hernia*); it may collapse and fall back, leaving the pleura full of air (*pneumothorax*); the cavity, as already mentioned, may be partly filled with blood, and the air may either pass in and out freely through the wound (*traumatopnœa*), or it may be forced into the cellular tissue under the skin, and spread over a considerable area (*emphysema*). This, however, is seldom extensive unless the lung is wounded. Finally, at a later period, pleurisy may set in, and even run on to empyema.

### *Injuries of the Lung.*

These may occur, as already mentioned, from mere contusion or compression of the thorax; they are very common as a result of fractures of the ribs; and occasionally they are met with as a result of external wounds, penetrating from the outside. The wound may be superficial or deep, it may be punctured, incised, or lacerated, with or without the entrance of foreign bodies, and it may be so trivial that it is never diagnosed, or it may cause instant death. The simpler forms of wound heal at once by the first intention, without any inflammation and with very great rapidity. Severe contusion, owing to the extravasation into the

air vesicles, is attended with a greater amount of consolidation and with rusty, blood-stained sputa for several days, but the dullness rarely extends and there is little or no fever. If, however, the extravasation is very great, or there is an external wound, so that the blood decomposes, intense septic pneumonia and even gangrene may follow; but there is always such an amount of pleural effusion, and the lung, as a rule, in these cases is so collapsed and compressed against the back of the thorax that the physical signs are very obscure.

**Symptoms.**—The two characteristic signs of wound of the lung are hemorrhage and the escape of air.

The former may take place into the bronchi, so that the sputa consists either of pure blood or of a frothy, bright red mixture, which in a day or two becomes rusty and black; or it may collect in the cavity of the pleura (hæmothorax) and gradually soak into the surrounding tissues, so that the skin on the loins becomes dark and ecchymosed; or it may escape externally, mixed with air, or almost bare. So with the air. In very rare instances, where the vesicles alone are torn without the pleura being injured, it may escape into the cellular tissue of the lung and make its way along the outside of the bronchi into the mediastinum, and so gain the root of the neck; or it may collect in the pleural cavity, entering at each inspiration, until it distends the thorax to its utmost and compresses the lung against the back; or, what is far more common, without entering the pleura at all, finds its way across into the cellular tissue and gives rise to surgical emphysema; or, finally, if there is a large open wound, it is sucked in and out of the chest at each respiration, mixed more or less with blood.

Besides these, other symptoms are usually present. The shock of such an injury is severe and sometimes fatal, even when the amount of bleeding is not great; anxiety and distress are always marked; sometimes the dyspnœa is slight, but usually it is severe, and if the lung becomes rapidly collapsed it may be extreme; there is a constant sense of irritation and tickling in the throat, with an intense desire to cough, but the deep, fixed pain in the chest prevents it, and if the hemorrhage is severe the patient may sink rapidly into a state of collapse.

### *Wounds of the Heart.*

In comparison with the lungs, the heart, as might be expected, is very rarely injured. The pericardium, however, may be torn, the valves ruptured, and even the substance of the heart rent across in violent compression of the thorax; the sternum or the costal cartilages may be broken and driven down into it, or it may be wounded from the outside by stabs or gunshot injuries. In a very few cases the pericardium only has been injured, or the surface of the heart. Much more frequently one of the cavities (the right ventricle especially) is laid open. Besides this, the pericardium and even the heart may be wounded by foreign bodies, fish-bones, etc., driven through the wall of the œsophagus.

Death may take place immediately from shock or from blood collecting in the pericardial space and stopping the action of the heart. If the patient escapes these, secondary consequences—continued hemorrhage, and, later, inflammation—are almost sure to prove fatal. Recovery is stated to have taken place in about fifteen per cent., but, probably from the interest attaching to such cases, this estimate is too high, even, for civil practice. Foreign bodies, however—even bullets—have been found *post-mortem* embedded in the substance of the heart, or projecting into one of its cavities; and fibrous cicatrices, with a thickened and adherent pericardium, have been demonstrated in many cases. Wounds of the auricle appear to be more fatal that those of the ventricle.

**Signs.**—In the absence of an external wound, the only signs are extreme shock with very great distress, and rapid, sometimes almost instantaneous failure of the circulation. Dyspnœa is very common, possibly pointing to pericardial hemorrhage and compression of the heart. Sometimes it is immediate, at others it does not come on for some minutes. Pain is very variable; it may be acute,

or it may be masked completely by the shock and distress. The heart sounds are usually inaudible, but in a few cases splashing and other abnormal ones have been heard. When there is an external wound the blood may pour out in a stream that is almost immediately fatal, or, especially in stabs where the opening is small or valvular, and when the wound in the heart is in the direction of the fibres, there may be very little.

The only treatment that is likely to be of any avail is absolute rest, cold, and opium; venesection has been recommended to relieve the heart, but it can very rarely be necessary. The external wound may be closed in the hope of arresting hemorrhage; but it must not be forgotten that accumulation of blood in the pericardium is one of the common causes of death. On one occasion I attempted to close the wound with sutures.

The great vessels may be injured in the same way; and, as a rule, accidents of this kind are even more rapidly fatal. Punctures of the aorta inside the pericardium, through the second intercostal space, and wounds of the coronary artery, end by allowing the blood to accumulate around the heart and compress it. Injuries to the other viscera in the thorax are more rare. A very few cases are recorded in which the œsophagus has been wounded from the outside. It is not uncommon to find foreign bodies driven through its wall from the inside, into the pleura, pericardium, and aorta. The thoracic duct has been divided, leading to a profuse flow of milk-like fluid during digestion; and it has also been ruptured without external wound, so that the pleural cavity became distended with chyle.

Rupture of the diaphragm is sometimes met with, on the left side, from extreme compression; and, of course, it may be injured anywhere by stabs, gunshot wounds, or fragments of ribs driven in. In most cases the neighboring viscera are fatally injured, but sometimes they escape, and the stomach or intestines may be squeezed up through the opening into the thorax, leading to great distress, with vomiting and dyspnœa. When the rent is small, they may be strangulated at once. If this does not happen, traumatic diaphragmatic hernia persists for the rest of life, as the wound, if it is of any size, is never repaired. It may be distinguished from the congenital form by its situation and by the absence of a peritoneal covering.

### *Primary Complications—Hemorrhage.*

This may come from arteries in the wall of the thorax (the intercostals or the internal mammary), from the lung, or from the heart and great vessels, and the blood may escape either internally (into the pleura, pericardium, or mediastinum) or externally. To diagnose one from the other, it has been recommended that a folded card should be introduced deep into the upper angle of the wound with its concavity outward; blood from a wounded intercostal will escape along the channel of the card, that from the thorax will pour out behind it.

(*a*) *External Hemorrhage.*—The intercostal arteries for the most part of their course are so protected under the margins of the ribs that they are rarely injured; at the back, however, they cross the interspaces obliquely. When they are divided in gunshot injuries or in resecting portions of ribs, the amount of hemorrhage is seldom large, but a few cases are on record in which it appears to have been very serious. If the wound leads down to a rib, the bleeding point should be well exposed, and an incision made on to the lower margin of the bone to ensure the artery being completely divided; then the soft structures may be pushed to either side with the finger-nail, so that the vessel may have a chance of retracting, and firm pressure may be kept up with the finger for a few minutes. If this does not succeed, the periosteum may be dissected back, carrying the artery with it, or forcipressure may be used, or as a last resource the wound may be plugged either with a dilatable india-rubber ball or by laying over it a piece of antiseptic gauze, filling the centre of this with pledgets of cotton, and forcing it into the wound, so that when it is slightly drawn out it expands in all directions, and compresses the vessel against the rib. Passing a ligature around the rib, close to its inner surface,

and resecting a portion of the bone, have been recommended when the hemorrhage could not be checked in any other way.

Wound of the internal mammary, owing to the size of the vessel and the freedom of its anastomoses, is much more serious, and in many cases has proved fatal either at once or later from secondary hemorrhage, even when no complications were present. The blood may escape externally, or into the mediastinum or pleura; and the only effectual method for arresting the flow is to cut down upon it and tie both ends, removing, if necessary, a portion of the costal cartilages or of the margin of the sternum. In the first three spaces this is fairly easy, but lower down it becomes more difficult, until in the fifth and sixth it is almost impossible.

When external bleeding comes from a wound in the lung, the diagnosis is generally only too easy; usually it means that a large, and therefore deep, vessel is torn across; air rushes in and out at the same time, and cough, dyspnœa, hæmoptysis, hæmothorax, and great distress are present as well. The external wound must be carefully but quickly cleansed; any accessible foreign body removed; and then the opening must be closed, the patient laid upon his injured side, and the most absolute rest enforced, in the hope that, as the blood collects and the heart beats more feebly, a coagulum may form and block the vessel. Tight constriction of the thorax is not well borne, but the injured side should be immobilized as far as possible. Stimulants should never be given; inhalation of turpentine, or subcutaneous injections of morphia and ergotine, may be tried; and apparent benefit has been derived from giving ten minims of tincture of ergot every hour, but the power of these remedies is not very great. Venesection was extensively practiced in the Crimea for the purpose of procuring collapse, but since then has been almost abandoned. If the patient survives, the amount of food and drink for the next few days should be reduced to the barest possible. If the pleura is filled with blood, so that the lung is collapsed against the posterior wall of the chest, and if the dyspnœa is very extreme, the wound may be opened, and the blood (or if it has coagulated, the serum) allowed to escape; but this can very rarely be required, and it must be remembered that it may always lead to fresh hemorrhage.

(*b*) *Internal Hemorrhage. Hæmothorax.*—Pleural extravasation nearly always comes from the lung; exceptionally it may proceed from the arteries in the wall, or from the heart or great vessels. The blood pours down at once to the lowest part of the cavity (depending, therefore, upon the position of the patient, whether he is sitting up or lying down) and soon coagulates. If the quantity is small and no air is admitted, it is absorbed again, and except for slight dullness and diminution of the breath sounds at the base, there is no way of diagnosing it. If, on the other hand, the amount is large, and if air gains access to it (pneumo-hæmothorax), inflammation, with a great increase in the pleural effusion, and suppuration, are almost sure to follow. When the air is filtered through the lung, instead of entering directly through an opening in the thorax, this danger is not so great.

When the extravasation is large, there are always symptoms of severe hemorrhage, in addition to the physical signs. The face and lips are white, the skin cold and moist, the patient sits propped up, rocking himself backward and forward, or throwing his arms from side to side, gasping for breath, and on the verge of syncope. The pulse is small and thready, too quick to be counted; there is intense thirst, the pupils are dilated, and often there are attempts at vomiting. In such cases death may ensue at once, partly from the loss of blood, partly from the difficulty of respiration, or after a time the severity of the symptoms may diminish and the pulse gradually recover. Generally, when this is the case, ecchymosis makes its appearance in the loins after a few days, due to the blood-color soaking through: sometimes the whole is absorbed, but more frequently the temperature begins to rise; perhaps there is rigor, the area of dullness increases, the dyspnœa becomes more marked, and it is clear that inflammation is setting in.

The early treatment of hæmothorax is not materially different from that of

wound of the lung with external hemorrhage. The first indication is to stop the bleeding. If it can be proved that this arises from one of the intercostal arteries or from the internal mammary, exploration would be justifiable, but hæmothorax under such conditions must be very rare. There is nothing at first but rest, cold, opium, ergot, and restricted diet; gallic and sulphuric acids and acetate of lead also enjoy a certain amount of reputation. Where the dyspnœa is extreme, and it is evident that it is due to collapse of the lung, relief may be given by inserting a fine cannula and allowing some of the serum to escape slowly, so as not to relieve the pressure on the wounded vessel too suddenly; but though this is not unfrequently necessary in pneumo-hæmothorax, it is very rarely required where there is only blood. Later, after three or four days, if the effusion shows any signs of increasing, or if there is any rise of temperature, this method of treatment is of very great service. It is very improbable, after such a lapse of time, that the increasing dullness is due to hemorrhage; much more likely it is the result of pleural effusion, consequent upon the tension; and allowing some of the fluid to escape under its own pressure not only diminishes the amount (if it is going to suppurate) but assists the absorption of the rest by allowing the lymphatics to act again. This may be repeated on several occasions, as the blood coagula slowly breaks down, but no force may be used to draw the fluid out.

Accumulation of blood in the pericardium or in the mediastinum is very much more rare; the former is nearly always associated with wound of the heart or the first portion of the aorta, the latter with injury to the internal mammary artery or the great vessels at the root of the neck.

*Hæmoptysis.*—If a large vessel is injured this may be profuse, the blood pouring out from the mouth and nose in gushes, until the patient sinks into a state of syncope. When profuse, it always points to injury of the lung, but the blood must be intimately mixed with the air, and bright red in color, for it to be conclusive. If it is not, it may have come from the larynx, or even have trickled down from the nose or some other part, and been coughed up again. After a day or two it becomes rusty and dark, more like the sputum of croupous pneumonia.

### *Pneumothorax.*

Air may enter the pleural cavity either from without through an external wound, or from within through a rupture of a lung or the bursting of a cavity in its substance. In the former it enters during inspiration, in the latter during expiration, the air being driven out of the lung into the pleural cavity so long as the tension in it is less than that of the trachea, but neither can occur unless the wound is of some size or very irregular. The adhesive force between the two layers of the pleura is such that, in spite of the elasticity of the lung, it requires some pressure to separate them. In incised wounds of the chest the pulmonary pleura has been seen in contact with the costal, gliding on it as the lung expanded or shrank, but not separating from it; and in punctures from ribs, where emphysema of the subcutaneous cellular tissue is exceedingly common, pneumothorax is exceedingly rare.

If there is an external wound the diagnosis of pneumothorax is evident at once; when due to penetration or rupture of the lung, the physical signs are the same as when it is produced by the rupture of a tubercular cavity. The chest on the injured side becomes over-distended, the intercostal spaces are bulged out, and the viscera displaced, the ribs remain motionless in respiration, there is tympanitic resonance over the whole of the front, but often, owing to the effusion of fluid, slight dullness at the base behind; and breath-sounds are entirely wanting unless they are transmitted along the wall of the other lung. On shaking the patient, metallic tinkling and splashing may be heard, if there is any fluid present as well as air, and when a coin is placed upon the skin and struck with another, a clear, bell-like sound is transmitted to the ear placed on the opposite side.

The treatment depends upon the amount of distress. Dyspnœa is always

severe, but if it is not extreme, the patient should merely be kept perfectly quiet in bed, propped up in the easiest position, until the air is absorbed. The rent in the lung becomes very small when it is collapsed; repair takes place readily, the air soon disappears, and the lung quietly expands again. If, however, the difficulty of breathing becomes very great, especially if signs of congestion of the opposite lung—frothy blood-stained sputa and moist râles—make their appearance, a fine cannula should be introduced, and some of the air allowed to escape under its own tension; and this may be repeated as often as required. Venesection is seldom necessary. Later, as already mentioned in hæmothorax, if there is fluid mixed with air at the bottom of the cavity, as much of it as possible should be allowed to flow away in the same manner.

### *Emphysema:*

In wounds of the thorax air may find its way into the subcutaneous cellular tissue, and be driven further and further by the movement of the muscles, until it spreads all over the body, and renders the features perfectly unrecognizable, the scalp, the palms of the hands, and the soles of the feet alone being exempt. The looser the skin the more distended it becomes, but it remains soft and white, and when it is touched there is a fine crackling sensation as the bubbles of air are driven through the meshes of the areolar tissue. The same thing apparently is met with in decomposition from incipient putrefaction, but the other conditions are very different.

Surgical emphysema may be caused in various ways, but there is only one, when it is due to the ribs being broken and driven into the substance of the lung, in which it attains any importance.

1. It may occur in the case of a simple valvular wound of the skin.

2. From wound of the pleura only, when air is sucked in during inspiration, and, owing to the obliquity of the opening, is unable to escape freely in expiration.

3. From rupture of the air vesicles, without the pleura being torn. This, which is distinguished as interstitial emphysema, is more likely to occur from injury to the apex of the lung, whether from external contusion or from violent compression of the thorax. The air gradually finds its way into the mediastinum, and from there to the root of the neck.

4. From fracture of the ribs. Owing to the cohesion of the pleural surfaces, the air, without ever really entering the pleural cavity, is forced across it by each act of expiration into the cellular tissue, and is driven further and further until it may extend over the whole body. Pneumothorax very rarely occurs; the wound in the pulmonary pleura, as it glides backward and forward, corresponds twice in every breath to that in the costal, and the air passes directly from one to the other.

Emphysema can be recognized at once by the peculiar crackling sensation when the skin is pressed. Generally it is limited to the region of the wound; those instances in which it is extensive are of comparatively rare occurrence. As a rule, it requires no treatment; the air soon becomes absorbed; when it is causing great inconvenience small punctures may be made in the skin, or pressure may be used to try and restrain it; but this is not very successful, and, fortunately, is seldom required. It is said to have proved fatal from interference with the respiration.*

### *Hernia of the Lung.*

Pneumocele, hernia, or prolapse of the lung is an occasional but rare complication of injuries of the thorax. It may be either immediate or secondary. In

[* A case of fracture of two ribs with emphysema from lung rupture was admitted into the United States Marine Hospital, Chicago, 1891. Death resulted on the third day. The skin over the neck was distended until it was completely separated from the underlying fascia.]

the former case there is generally a wound of some extent in the parietes, and the lung is forced out through it by a violent effort at expiration when the glottis is closed. It may be injured itself or it may not, but as soon as it is squeezed out through the rent it expands so that it cannot return, and rapidly becomes congested. In extreme cases it may be strangulated. If seen shortly after the accident an attempt may be made to return the protrusion, and, if necessary, the wound may be slightly enlarged for the purpose; but if some time has elapsed, and the tissue is very much congested, it is better left where it is to slough off and granulate over; or its separation may be assisted by ligature or actual cautery. A very few instances are recorded in which, owing to extensive injury of the thorax, an immediate prolapse of the lung has occurred without an external wound.

The consecutive variety may not make its appearance until some considerable time after the receipt of the injury, and if there has been a wound it must have healed first. It forms a soft circumscribed tumor projecting through the wall of the thorax under the skin, swelling out on expiration and shrinking on inspiration. On coughing there is a distinct impulse; if it is pressed upon it collapses readily with a feeling of soft crepitation, and the margins of the opening can be plainly felt. It is resonant on percussion, and the respiratory murmur is loud and coarse in comparison. In some cases it is the result of extensive rupture of the intercostal muscles; in others, where its formation is very gradual, it is probably due to chronic inflammation weakening the wall of the thorax at one spot, and allowing the lung slowly to force its way through. The only treatment required is a belt or truss, according to the size and situation of the protrusion, to restrain it and protect it from injury.

### *Foreign Bodies.*

Bullets and other weapons impacted in the wall of the thorax present no special peculiarity; they should be removed as soon as convenient, but it must be remembered that doing so may give the first proof that the injury involves the cavity of the chest as well as its wall. If the foreign substance is lodged in the pleura, it may either (as in the case of fragments of clothing, wadding, splinters, etc.) remain in the neighborhood of the external wound, or if it is heavy, like a bullet, sink down to the bottom, and rest upon the surface of the diaphragm, near the spine. Occasionally under these circumstances it becomes encysted; much more frequently acute inflammation, running on to suppuration, sets in, and the foreign substance is discharged through the opening made to evacuate the pus.

The same thing occurs when it is lodged in the lung. Instances are recorded in which bullets, fragments of bone, or of metal, and other similar substances, have remained quiet for years, becoming surrounded by fibrous tissue and encysted, or at length have caused a certain amount of chronic suppuration, leading to their discharge either externally or through one of the bronchi. As a rule, however, the termination is not so successful: either acute septic pneumonia, running on to gangrene, occurs, or chronic inflammation, ending in phthisis, follows.

The question of extraction depends entirely on whether the foreign body is accessible or not. No attempt should be made to remove it from the pleura, unless there is a distinct indication as to locality; and in the case of the lung the greatest caution must be exercised; fatal hemorrhage sometimes follows the extraction of a weapon, but if there is a reasonable suspicion that anything is left the external wound should not be closed.

### *Secondary Complications.*

The secondary troubles that occur after injuries of the chest are for the most part the result of inflammation, which may involve the walls of the thorax, the pleura, pericardium, lungs, or heart.

*Extra-mural Suppuration.*—Abscesses may form as the result of contusions, either in the superficial tissue or deeper under the muscles, when they often spread

for long distances before they point. In all cases they should be opened at once; the deeper ones can often be reached from the axilla, along the margins of the muscles, but if this cannot be done the opening must be made wherever the drainage is likely to succeed best. If there is any doubt as to the existence of pus, or the direction of important vessels, Hilton's method should be employed.

*Necrosis* of the ribs or sternum is not unfrequently assigned to injury. Sometimes it may be due to this alone, but in most of the cases in which this complication is present there is a distinct history of tubercle or syphilis.

*Abscesses* sometimes form between the pleura and the ribs, or in the mediastinum. The former are generally associated with necrosis and soon point externally, though they have been known to burst into the pleura. The latter may attain a very large size and cause compression of the vessels and severe constitutional disturbance before their nature can be determined. Usually they point just to the left of the sternum, and if pulsation is communicated to them from the heart they may easily be taken for aneurism; in other cases they work their way out through the bone, or pass upward into the neck, or downward along the internal mammary artery; or extend into the pleura or pericardium. No time should be lost in opening them as soon as the diagnosis is made.

*Pleurisy and Empyema.*—In fracture of the ribs and in most cases of severe contusion of the thorax, a certain amount of effusion is thrown out by the costal pleura, leading to thickening of the membrane and sometimes to the formation of adhesions between the two surfaces. If, however, there is a large extravasation of blood, or if air or other foreign substance finds its way in, the inflammation is more severe; and if the irritation is kept up, or if it is of a very intense character, it ends in suppuration (empyema or pyothorax).

When this occurs the suppuration may be very acute, ushered in by rigors and high fever; or it may be chronic, the effusion gradually increasing, and becoming more and more purulent, as when empyema succeeds serous pleurisy. In most cases it is general, but it may be local at first.

The physical signs are usually well marked. If there is no wound the side of the thorax is enlarged and the neighboring viscera displaced, the breath sounds are either altogether lost over the lower part of the chest on that side, or, if the effusion is not so great, they are replaced by weak and distant bronchial breathing. Over the same area there is absolute dullness, the level rising day by day, and varying a little with the position of the patient; and sometimes ægophony can be heard at the upper margin. When there is an open wound the pleura is filled to a great extent with air, and there is a profuse discharge of fluid, sometimes pure pus, sometimes broken-down blood-clot, according to the amount of hæmothorax that preceded the empyema and the length of time since the accident.

The pleurisy that occurs in connection with simple fracture nearly always gets well of itself; if fluid does collect, and is not absorbed, it may be withdrawn with an aspirator. If suppuration sets in, the first consideration is to ensure perfect drainage, so that the pus cannot be pent up and decompose. When there is an external wound it must be enlarged, carefully examined, and explored with the finger to ascertain if there is a foreign body which has been overlooked, or any other cause; and in most cases it is advisable to make a second opening at once. When there is no wound aspiration may be tried; but if the fluid is of such a character that it cannot be evacuted in this way (if, for example, it consists largely of blood-clot that has not yet become liquid); or if, after a certain amount of success, the cavity begins to fill again, it must be drained. If it is done at once, before the pleura has become condensed and thickened, the lung will expand again and become adherent to the wall of the thorax.

*Pneumonia.*—Simple wounds of the lung, as already mentioned, generally heal by the first intention, with very little consolidation or effusion. If, however, there has been much contusion or extravasation; if there is an external wound; and particularly if a portion of some foreign substance, such as clothing or wadding, has been carried in, or has entered through the larynx, decomposition may

set in, and excite intense inflammation and suppuration. Sometimes even then it ends in a local abscess, the pus suddenly bursting into one of the bronchi, or working out through the wall, along the track of the original wound, or even drying up and ultimately becoming caseous or calcareous; but much more often it runs on until the greater portion of the lung or of one of the lobes is involved; and occasionally it is so acute as to end in gangrene.

The locality of the pneumonia depends upon the seat of injury. The physical signs, when they can be made out, are the same as those of the ordinary croupous form, but they are usually obscured by the presence of empyema, pneumothorax, or other complications. The sputa may be rust-colored, even when there is no inflammation from traumatic hemorrhage into the air vesicles. High fever, however, following a severe injury to the lung, renders its presence practically certain. The prognosis depends upon the amount of lung involved and upon the cause.

Very little can be done in the way of treatment; constant inhalation of moist air impregnated with some volatile antiseptic, may be tried to limit the amount of decomposition; but if the condition of the breath indicates that gangrene has set in, almost the only hope lies in incision and drainage. Too often, however, the condition of the patient is practically hopeless. For the rest, all that can be done is to maintain the strength of the patient, and, if there is extensive pleural effusion, relieve the breathing by tapping.

### Diseases of the Chest Wall.

*Chronic Abscess.*—This may arise from a suppurating hæmatoma, or follow the caseation of a tubercular deposit. Very often it originates in connection with a carious rib. The symptoms are usually distinctive, but care should always be taken to prove that the sac has no communication with the thorax. The cavity should be laid open freely to allow the contents to escape, explored with the finger, washed out with perchloride solution, and drained. The tube requires removing upon the second day; after that the wound may be covered with wood-wool and left until it is sound.

*Tubercle* may affect the subcutaneous tissue, leaving long sinuses lined with pale, flabby granulations (in one case under my care they extended across the front of the chest from one axilla to the other), or it may commence in the subperiosteal layer of the bones. It should, in any case, be thoroughly scraped out, and the wound well powdered with iodoform. Fortunately the pleura becomes so thick that there is very little risk of an empyema following.

*Gummata* are of frequent occurrence upon the sternum, leaving deep, circular, punched-out sores, with the bone beneath bare and rough.

In addition, all forms of tumors that develop in connection with fibrous or connective tissue, bone, or cartilage, are met with upon the thorax. The treatment, of course, depends upon their character; in some cases their removal is comparatively simple; in others it may be necessary to excise the subjacent bone and expose the pleura or even the pericardium. Sarcomata can sometimes be shelled out, but great care must be taken to ascertain whether they have any deep connection.

## OPERATIONS UPON THE THORAX.

### Paracentesis.

Paracentesis of the pleura is performed either for exploration (to ascertain the presence or the nature of fluid), or to relieve the tension in the cavity, so that the lung may expand again, and the balance between absorption and secretion be once more restored.

For purposes of exploration a large hypodermic syringe is the most suitable

instrument. Care should be taken that it is absolutely clean (it is not sufficient to draw even a strong carbolic solution through the needle; all cannulæ before using should be boiled in liquor potassæ; nothing else will ensure freedom from putrid grease in the interior), and unless it is intended to empty the cavity, only a small amount should be withdrawn. It is very easy by means of repeated punctures to convert a simple pleurisy into an empyema. The locality selected depends upon the physical signs, but the thinnest part of the chest wall that is available should be chosen; the skin should be pulled a little to one side, so that the opening may be valvular; and care should be taken to pass in over the upper border of a rib.

If it is intended to withdraw the fluid an aspirator should be used, adopting the same precautions, and keeping up a uniform but slight amount of suction. The operation may be required for hæmothorax; for pleurisy, if the effusion is so large as to interfere with the action of the opposite lung or with the heart, or if, though it is not large enough for this, it fails to diminish under other methods of treatment; for hydrothorax occurring on both sides (as sometimes in Bright's disease); and for empyema.

The usual situation is in the seventh or eighth space, just in front of the angle of the scapula. An anæsthetic is not required; if the patient is very nervous the ether spray may be used. The semi-recumbent position is the most convenient; the patient cannot lie upon the sound side on account of his respiration, but a finger must be kept upon the pulse, as sometimes syncope occurs if a large quantity of fluid is withdrawn, or if it comes away rapidly, probably from the viscera being unable to accommodate themselves at once to the altered conditions. A small incision should always be made through the skin with a scalpel; the walls of the thorax, even when it is full of fluid, are apt to yield a little; the trocar, however sharp it may be, does not penetrate readily; and if it does not enter smartly it may push the thickened pleura in front of it, and fail to reach the cavity. At the same time it must be guarded with the thumb, so that it may not be driven across the pleura when the resistance ceases.

The quantity of fluid withdrawn must naturally be guided by the circumstances of the case, but no attempt should ever be made to empty the cavity, and if the pulse becomes weak, or any blood appears in the aspirator, or the patient begins to cough, the needle should be withdrawn at once, and the puncture sealed with collodion. It very rarely happens that any serious consequences follow, but syncope, embolism (from the pulmonary veins), and œdema of the lung (owing in all probability to the paralysis of the walls of the vessels, caused by prolonged anæmia) have been known to occur; and, owing to the feeble nutrition of the tissues and the inflammation already present, there is distinct danger of the fluid becoming purulent.

### Drainage.

Drainage of the pleura is very rarely required except for empyema. In the traumatic variety (that which is caused by a foreign body entering the bronchi, by hæmothorax, or by the rupture of a cavity) it is nearly always necessary. On the other hand, when an empyema follows simple pleurisy, aspiration may be tried first, unless it is already pointing. In children, in particular, it is often successful, and although the chance is less in the case of adults, it is always worth the attempt. The cavity, of course, is not emptied, and the residue of the pus must be removed by absorption.

In addition to the physical signs pointing to fluid in the pleural cavity, the presence of pus is indicated by rigors, hectic, or œdema of the skin; but it should always be suspected, especially in the case of children, if after any of the acute specific fevers or an operation, or, indeed, any serious illness, recovery is unaccountably delayed, and the patient, instead of improving, begins to fail and go back. If, under such circumstances as these, there is any indication of fluid in the pleura, there should be no hesitation in using an exploring syringe.

as possible with the finger and a probe. Usually it runs upward and backward across the general direction of the ribs, so that it may be necessary to commence at the second and remove portions of five or six; the first, of course, should never be touched.

A single vertical incision is usually sufficient; occasionally two may be necessary, or it may answer better to raise the soft tissues in a flap [Schede's operation]. As a rule, the ribs lie so close together that it is impossible to slip the finger nail between them, and the preliminary section must be made with a saw, commencing over the cavity at its anterior margin. As soon as a portion of one or two has been excised, a better idea can be formed as to what is required. According to Pearce Gould, the whole of the bone that forms the outer wall of the empyemic cavity must be taken away, a free opening being first made in front, and then the rest of the wall divided from within by means of cutting forceps. [Subperiosteal resection of the ribs is a much less serious operation, and it may be performed with comparatively little hemorrhage, and often without wounding the intercostal vessels or pleura. Not only does the chest wall collapse, but the bony rib is reproduced. This ideal result I had the pleasure of seeing in a case at the United States Marine Hospital, Chicago, 1891.]

### Pneumonotomy.

Incision of the lung may be practiced, according to Godlee, in cases of gangrenous cavities, abscesses caused by the extension of suppuration from other parts into the lung, abscesses connected with foreign bodies, bronchiectatic cavities, provided they are single (multiple ones can hardly receive much relief this way), and tubercular cavities, if there is only one, and the cough is very harassing. In one or two cases a similar operation has been practiced for hydatid disease, and a few instances are recorded in which tumors have been removed from the lung. The localization of the disease and the treatment of the pleura are the chief difficulties.

No incision may be made until the existence and accessibility of the cavity have been proved by puncture, and even then the greatest care is required, for the lung, unless it is consolidated by inflammation, is so yielding that a thick-walled sac can easily be pushed to one side. As a rule, cavities should not be approached from behind, for the large vessels run for the most part along the posterior surface of the bronchi. The size of a cavity cannot be estimated from the amount of fluid that is coughed up; according to Godlee, upward of a pint may come within twenty-four hours from a space that would not hold as much as two ounces. If a cavity is found, the lung tissue should be incised, and explored as far as possible with the finger, part of a rib being removed if necessary, and a large drainage tube inserted. The shape is always very irregular, and it must be a long time before the sloughs have separated, and cicatrization can procure its obliteration.

The treatment of the pleura presents unusual difficulties. There can be no doubt that it is not advisable to incise a putrid cavity in the lung unless the pleural surfaces are adherent. If there is localized gangrene, and if it has already lasted for some time, the danger is not so great; adhesions are usually present under these conditions, and the lung is so consolidated by inflammation that it is in but slight danger of collapsing; but in acute cases and in bronchiectasis it is impossible to be certain. An attempt may be made to find out by ascertaining the mobility of the lung; if a needle is driven through an intercostal space into the pulmonary tissue, it will show to a certain extent by its movement whether the lung is fixed or not, but it is very easy to place too much reliance upon this. In some instances it may be possible to suture the two surfaces together and wait for a week, or to procure adhesions by means of the cautery applied to the intercostal muscles, but often it is impossible to wait so long, and even then the adhesions are so soft and delicate that the greatest care must be taken not to break them down.

[Dr. E. Wyllis Andrews, of Chicago, showed to the Chicago Medical Society,

n 1892, several large calcareous concretions taken from the human lung by in-ision. At the date of the report, the patient had much improved subsequent to he operation.]

### Paracentesis of the Pericardium.

This may be required for serous effusion, when the quantity is increasing to uch an extent that the action of the heart is failing, or for a collection of pus, uch as is not uncommon in the pyæmia that complicates acute necrosis. It may e performed in any interspace from the third to the eighth (the fourth or fifth is sually recommended), preference being given to that which shows the clearest ndication of fluid, and a spot should be selected about one inch from the edge of he sternum, so as to avoid the internal mammary artery on the one side and the leura on the other. The direction of the puncture must depend upon the locality; f it is on the left of the sternum, the needle should be pushed backward and oward the right. The right ventricle of the heart has been perforated on several ccasions.

A preliminary incision should be made through the skin and a fine aspirator eedle used. If the fluid is clear and serous, the cavity should not be emptied; emoval of part will probably give sufficient relief; if, however, it is purulent this is often indicated by œdema of the skin), the incision should be gradually eepened until the pericardium is exposed sufficiently to introduce a drainage tube.

# CHAPTER XVIII.

## *INJURIES AND DISEASES OF THE ABDOMEN.*

## SECTION I.—INJURIES OF THE ABDOMEN.

### CONTUSIONS.

Blows upon the abdomen may affect the walls, or the viscera, or both together. They are always accompanied by a very severe degree of shock, and it is said that a fatal result has followed without any structural lesion having been discovered at the autopsy. Certainly death may result from such apparently trivial injuries as rupture of the parietal peritoneum without hemorrhage, or puncture of a small hydatid cyst of the liver, probably owing to reflex paralysis of the heart.

Owing to this peculiarity it is often impossible to form a conception as to the extent of the injury (the viscera may be reduced to pulp without the skin showing a sign of bruising, as in what used to be called wind contusions, from spent round-shot), and the prognosis must be very guarded. The shock may pass off within a few minutes or a few hours, or it may prove fatal, or it may be followed, without any break or interruption, by signs of hemorrhage or of rupture of some of the hollow viscera.

(*a*) *Contusion and Subcutaneous Laceration of the Wall of the Abdomen.*—A hæmatoma may form in the subcutaneous tissue, or in the sheath of the muscles; in some cases the extravasation is very extensive, usually it is absorbed (leaving, if the muscle has been much injured, a weak spot in the wall of the abdomen through which a hernia may take place subsequently), but occasionally suppuration sets in. Abscesses of the abdominal wall caused in this way are characterized by the enormous amount of induration that surrounds them, and not unfrequently, even when they have no communication with the viscera, by the fœtid nature of their contents.

Laceration of muscles, especially of the rectus abdominis, is not a rare occurrence. It may be caused by a sudden effort, as, for example, in parturition, or by a blow when the muscle is rigidly contracted. In tetanus it is not uncommon, and it is said to be of frequent occurrence after typhoid fever, owing to the degeneration of the contractile substance. The signs are characteristic, but, unhappily, if the rupture is complete, nothing can be done to secure union of the ends, and an abdominal support must be worn afterward. Laceration of the diaphragm can only be recognized, if the patient lives, by the subsequent occurrence of traumatic phrenic hernia.

The parietal peritoneum sometimes gives way by itself, owing to its want of elasticity, but this is not so common as in the case of the visceral layer, probably because of the presence of the subperitoneal fatty tissue. It may be followed by peritonitis.

(*b*) *Rupture of the Viscera.*—A very slight degree of force is enough sometimes; an enlarged spleen, for example, or a distended bladder with atrophied walls, tears at once, and the latter, at least, will give way under the mere pressure of the muscles. Most instances, however, are due to extreme degrees of violence, the worst being what are known as buffer accidents. The liver suffers the most frequently, on account of its size and position; sometimes the gall-bladder is torn as well. The stomach may give way (especially if it is distended), usually near the pylorus. The small intestine may be torn across (generally at the end of the duodenum, for here the most movable part is joined to the most fixed), the spleen may be ruptured, the kidney, its pelvis, or the ureter lacerated, and the mesentery,

with its blood-vessels, rent in any direction. The pancreas, owing to its position, usually escapes, unless, as sometimes happens, the contents are completely crushed.

The diagnosis of many of these injuries is impossible until secondary consequences have made their appearance. The patient simply lies utterly prostrate, and it is not possible to tell whether his condition is due to shock alone or to shock combined with hemorrhage, or rupture of the viscera. The bladder may be excluded by passing a soft catheter; if it is empty at the time of the accident it is almost certain to have escaped (unless the pelvis is fractured too); if it was full, and has given way, nothing but a little blood-stained fluid follows when the catheter is passed. Hemorrhage into the peritoneal cavity may be diagnosed by the increasing intensity of the collapse, the yawning and jactitation of the patient,

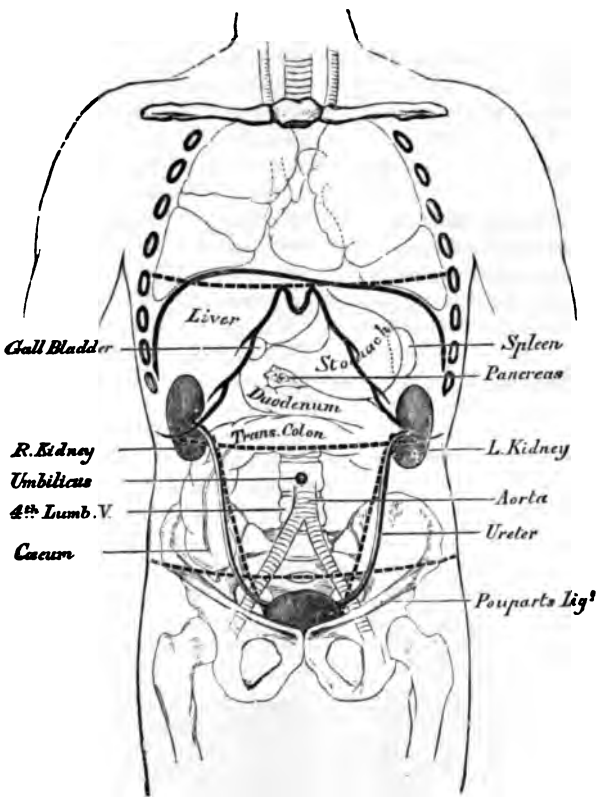


FIG. 367.—Diagram Showing the Position of the Abdominal Viscera.

and by the dullness in the flanks, the level of which continues to rise, and varies with the position; but this gives no information as to whether it is simple rupture of some mesenteric vessel, or a hopeless laceration of the liver. In rupture of the stomach there may be blood-stained vomiting; but, again, this may arise from simple bruising of the mucous membrane, or, particularly when the rent is extensive, it may not occur at all. The rapid accumulation of gas in the peritoneal cavity, causing obliteration of the liver dullness, points in the same direction. If the intestine is lacerated vomiting may occur, but the passage of blood *per anum* is more decisive. Prof. Senn proposed, in cases of this kind, to inflate the rectum and large intestine with hydrogen or some other unirritating gas, and undoubtedly in the case of bullet wounds, where there is an external aperture, and the gas that escapes can be collected and identified, this proceeding is of some benefit. In

other cases it can only be considered an indication if, after it is injected, resonance makes its appearance in some locality into which the intestines do not usually penetrate, as, for example, between the liver and the anterior abdominal wall.

**Treatment.**—In the vast majority of these accidents active measures are out of the question. The patient must be kept perfectly quiet in bed, well under the influence of opium, and with a large ice-bag over the injured part, so arranged that it does not rest its weight too much upon it. Stimulants should be avoided if possible; sometimes, when the heart is distinctly failing, they must be given, but if there is any hemorrhage, they are only likely to precipitate the end. Only a little ice (in small fragments, and not too often) may be allowed by the mouth; any food that is considered advisable in the first forty-eight hours should be given in the form of suppositories or small enemata.

In exceptional instances it may be possible to form a more accurate diagnosis. If, for example, there is clearly some fracture of the ribs over the liver, and the hemorrhage is serious, or if blood-stained vomiting and rapid distention of the peritoneal cavity with gas are followed within a few hours by peritonitis, indicating rupture of the stomach or intestine; or if the bladder contains but a small quantity of blood-stained urine, in spite of the fact that none has been passed, it is undoubtedly justifiable to open the abdomen, try to find the seat of injury, deal with it as it requires, and wash out the cavity thoroughly with hot water. The spleen and kidney have been removed for hemorrhage; rents in the liver have been sewn up; the bladder has been sutured many times successfully, and life has been preserved even after fæcal matter has been extravasated into the peritoneal cavity. Unfortunately, the proportion of cases in which such a proceeding can be recommended is a very small one; in by far the majority, opium is the only resource.

## WOUNDS.

Wounds of the abdomen are divided into those that penetrate the peritoneal cavity and those that do not, and the former again into those that are accompanied by injury to the viscera and those which only implicate the wall.

1. *Non-penetrating wounds* may be incised, punctured, or lacerated. If there is any doubt as to the peritoneum being involved, and the wound is more than a puncture, or if the instrument with which it was inflicted is dirty, the patient should be placed under an anæsthetic and the opening carefully enlarged, each layer of tissue being divided successively upon a director until, if necessary, the subperitoneal fat is exposed. In other respects the wounds must be treated on ordinary principles, deep sutures being used to bring the various layers together after the tissues have been thoroughly cleansed, as, owing to the constant movement of the part, it is very difficult to maintain accurate apposition in any other way. If the wound is of any size ventral hernia is very likely to follow, unless an abdominal support is worn.

2. *Penetrating Wounds.*—In all wounds that involve the parietal peritoneum (except needle punctures) the injured tissues should be thoroughly examined (the skin wound being enlarged, if necessary), cleansed, and accurately brought together with the serous surfaces in contact. A continuous catgut suture should be used for the peritoneum (so as to make sure of immediate union), if from the amount of bruising or from other causes it is doubtful whether the other tissues will heal at once. On the other hand, with a clean incised wound, the sutures may be passed through everything, peritoneum, muscles, and skin, as after an operation. Opium is usually advisable, and the dressings must be abundant and elastic (a sponge wrung out of carbolic solution may be placed next the skin with wood-wool over it and all around it), so as to ensure the parts being kept at rest and in accurate apposition.

(*a*) When it is certain the viscera are not hurt nothing further is required. The patient must be kept perfectly quiet in bed, on liquid food, until the wound is sound.

Shock is always very severe and must be treated by warmth, and, if the heart shows signs of failing, stimulant enemata. Opium is absolutely necessary, as it is imperative to keep the bowels confined and as quiet as possible. Nothing should be given by the mouth for at least twenty-four hours. If there is very great thirst it can be relieved by a warm water enema with much less disturbance. As a rule, there is very little urine secreted, and if the bladder is emptied at the time of the operation it can usually be left for twenty-four hours. If at the end of that time the patient cannot pass it without straining, or if there is a complaint of distention and discomfort, the catheter must be used again. Small quantities of dilute beef-tea may be given on the second day, or a little weak arrowroot. Milk is better withheld, as it is apt to pass into the small intestine in curdled masses.

Injuries of the kidneys, bladder, etc., are dealt with elsewhere.

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## SECTION II.—SURGICAL AFFECTIONS OF THE STOMACH.

### Operations on the Stomach.

A considerable variety of operations may be performed upon the stomach. It may be opened and stitched to the wall (gastrostomy), or to the adjacent intestine (gastro-duodenostomy or gastro-jejunostomy); it may be opened (either for the removal of foreign bodies or for operations upon its mucous surface), stitched up again, and returned into the peritoneal cavity; or it may be opened, part of its wall excised, and the wound secured by sutures.

1. *Gastrostomy.*—This may be performed for cancerous, traumatic, or syphilitic stricture of the œsophagus, when dilatation by bougies or tubage is either impracticable or inadvisable. Until within the last few years, the mortality, especially in cases of carcinoma, was appalling, the patients dying either from peritonitis or exhaustion. Of these the former can be prevented; the latter can only be avoided by operating before the patient's strength is too much reduced. It must, however, always be recollected that this operation is in no sense a curative one; it merely treats a symptom, and if this can be done equally well with less risk to life in some other way, that way should certainly be preferred

The line of the incision is parallel to the margin of the ribs upon the left side. The opening must, as Greig Smith points out, be as high as possible, so as to avoid traction upon the stomach; but it must be at least an inch from the edge of the liver and from the ribs. This point marks the middle of the incision, which is about two inches and a half in length. The skin and superficial structures are divided, the sheath of the rectus exposed, and, as recommended by Howse, opened in a vertical direction. If this is done, and the fibres of the muscle separated from each other in the same line with the handle of the scalpel, the orifice is surrounded by muscular fibres, and the risk of prolapse of the mucous membrane and escape of the contents of the stomach diminished. The subperitoneal fat is then exposed, divided, and the peritoneal cavity opened in the usual way.

If the stomach is distended it may present at once; nearly always, however, it is empty and collapsed, hidden between the liver and the colon. When this is the case the fingers must be introduced, and passed along the under surface of the left lobe; the first structure they touch after leaving it must be the stomach. The opening in the stomach should preferably be near the cardiac end; but if this causes the least traction, it must be made in the most convenient situation.

The further stages depend upon whether the stomach is to be opened at once or not. If the time can be afforded, there is no doubt the latter is advisable; even twelve hours will often seal the surfaces together; in two days the lymph will be comparatively firm; but when the patient is exhausted from the combined

*Diverticula* also are sometimes found, especially in the congenital form, and not unfrequently they are very large, extending upward in the front wall of the abdomen between the muscles, or behind them in front of the fascia. These intraparietal sacs are of great importance, for if a hernia descends it may easily be returned into the diverticulum instead of the abdomen, leaving the strangulation, if one is present, unrelieved.

*Hydrocele* of the sac is a very rare condition. Several pints of fluid may collect in it when the orifice is temporarily obstructed by a hernia; but the term *hydrocele* should be reserved for those cases in which fluid accumulates after the neck of the sac has been completely and permanently closed. It has been met with in femoral and in inguinal herniæ, and it may render the diagnosis very difficult.

2. *The Contents.*—With the exception of the pancreas, all the viscera of the abdomen have been found in hernial sacs at one time or another; the most common is the ileum, especially the last few feet, and then the omentum. The cæcum and colon, which come next, are much more rare, and the others are only met with in congenital malformations.

When the protrusion consists of intestine it is called an *enterocele;* when omentum, *epiplocele;* if both are together, *entero-epiplocele.* In this case the intestine nearly always lies behind the omentum, concealed by it; in some rare instances, however, it is in the middle, in a kind of inner sac. Cystocele, gastrocele, and other similar terms, are occasionally used.

3. *The structures that cover a small hernia* are but little changed; they merely stretch and yield, and the sac can still be easily reduced. As the size increases, however, this becomes different. The subserous fat wastes and grows fibrous; the sac becomes adherent; it is thickened in some places from the irritation of the truss, and thinned in others; the coverings become matted together, so that their structure can no longer be distinguished; and at length the parts around are hopelessly distorted from the continued traction, so that, for example, the internal inguinal ring is dragged opposite the external.

FIG. 370.—Femoral Hernia.

**Symptoms.**—A hernia often causes griping and colicky pains in the abdomen, probably from the way in which it drags on the mesentery and impedes peristalsis; while dyspepsia and a feeling of discomfort on exertion and after meals are nearly always present; but in many cases either this is not noticed or is put down to other causes. The character of the swelling depends upon its contents. When the main bulk consists of intestine the surface is uniform and elastic; a distinct impulse can be felt when the patient coughs or strains; and if it is of any size and the walls are not too tense, it is resonant on percussion. Omentum, on the other hand, feels hard and doughy; the surface is uneven, and though there is a certain degree of impulse in most cases communicated from the abdomen, the swelling does not become tense and expand in all directions in the same way as intestine. The method of reduction, too, is different; the intestine slips back suddenly, often with a peculiar gurgling, and the patient experiences at once a feeling of relief; omentum disappears more gradually, and if both are down together, is almost always the last to go.

The sac can only be reduced in the early stage of a hernia, before it has acquired a definite shape and contracted adhesions to the surrounding structures.

**Treatment.**—A hernia must be prevented from descending, either by means of a suitable contrivance (a truss or belt), or by closing the aperture through which it has escaped. The former is only palliative, although, if it is adopted sufficiently early in children and carried out with proper care, a permanent cure may generally be looked forward to; the latter is known as the radical cure, and aims at allowing the patient to dispense with a truss altogether.

1. *Trusses.*—A truss consists of a pad or cushion attached to a metal spring surrounding the body, so arranged with straps that its position remains unaltered in the most varied movements. Inelastic trusses, made of a leather band (as the Moc-Main truss) instead of a spring, are of use in large irreducible hernia, but cannot be relied upon for ordinary work; they fail to exert sufficient pressure when the patient is stooping, the position of all others in which the hernia most easily descends.

The pad is generally made of cork, covered with flannel, linen, and wash-leather; but rubber, water, and air cushions may be used where pressure is painful

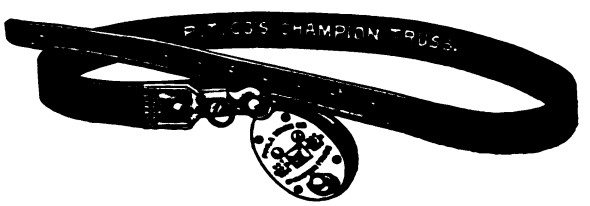

FIG. 371.—Truss for Inguinal Hernia.

or the surface irregular. For an oblique inguinal hernia it should be pear-shaped, about three inches long, two inches at its broadest part, and three-quarters of an inch in thickness: the outer surface is flat, and has two studs upon it for the attachment of the straps; the inner is slightly convex, looking upward as well as backward, especially when the abdomen is protuberant, and lies upon the internal ring and the inguinal canal, not touching, though it may come quite close to, the pubic spine. If the hernia is congenital, the pad should be prolonged downward between the scrotum and the thigh, tapering off gradually (rat-tail truss); and if it is direct; or if it is an old oblique one with the rings dragged nearly opposite each

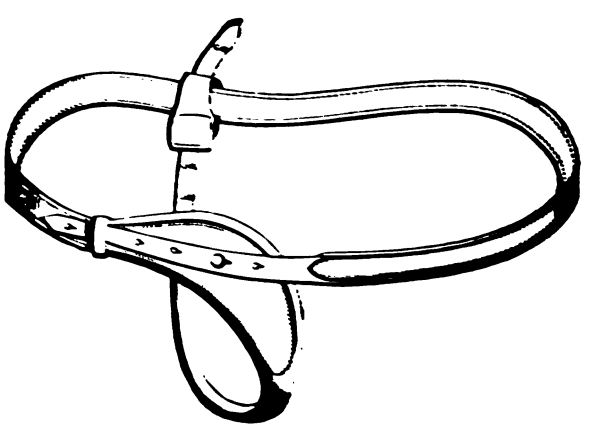

FIG. 372.—Single Double Spring Truss for Congenital Scrotal Hernia.

other, a cross-bar may be added over the upper border of the pubic symphysis, so that the pubic spine lies, as it were, in a recess. In these cases, however, it is usually advisable for the patient to wear a double truss: very often, especially in the direct form, there is a certain amount of weakness on the other side as well; the inconvenience of a double truss is no greater than that of a single one; and if the two pads are held together by a strap or cross-bar over the pubes, the security is very much greater.

Weeks's pads are based on a different principle: they are made of hollow rubber, capable, if need be, of being filled from non-absorbent material, and they

that the pressure falls, not upon the opening, but all round it. The pad for an oblique inguinal hernia, for example, is cut like a horse-shoe with one side (that which covers the inner pillar) longer than the other; the spring is fixed to the geometric centre; the spermatic cord and the pubic spine fit themselves into the interval between the sides of the shoe; and the rupture is prevented from descending by the tension across the opening; that for a direct hernia is in the form of a ring, the centre of which corresponds to the axis of the hernial opening. In either case the tissues project upward in the centre, where there is no pressure; and this and the double bearing greatly diminish the chance of slipping.

For a femoral hernia the pad is smaller, beveled a little on the outer side to avoid pressure upon the femoral vein, and above so that it may fit well up under Poupart's ligament and bring the walls of the canal together. If an operation has been performed, and Gimbernat's ligament freely divided, this is not enough; in such cases a thigh-belt, laced up around the upper part of limb, with a triangular pad over the saphenous opening and filling up the greater part of Scarpa's triangle, is required, and even this will only prevent the hernia increasing in size.

Umbilical herniæ are best kept in place by a shallow concave plate, which at the same time supports the lower part of the abdomen. Nipple-shaped projections only make the opening larger. Pads with spiral springs are very comfortable, but cannot be relied on where strength is required, as they are apt to yield if the strain is severe.

The pad in most cases is rigidly attached to the spring; but in some, as in Salmon and Ody's, there is a ball-and-socket joint, and in others it can be shifted

FIG. 373.—Double Femoral Truss with Circular Spring.

upward or downward and fastened in any position. The spring passes round the rim of the pelvis, fitting closely to the figure, just below the iliac spines, and above the glutei. If the truss is a single one the free end is beaten out flat, and shaped so as to cling round the opposite hip. Its strength is regulated by the muscular condition of the patient and the size of the rupture, and it should always exert slight pressure, even when the body is at rest. Where the employment necessitates great exertion, it may be advisable to have two trusses of different strength. The under strap, which prevents riding up, should always be fastened to the lower stud, and in the erect position should be moderately tight.

*Measurements.*—In young adults with a flat abdomen it is sufficient to give the measurement from the pubic symphysis to the anterior superior spine, and from this round the back to the opposite one; but in all other cases the exact line of the truss should be followed, from the ring to the spine of the ilium, from this to the opposite one, and then back to the ring again; and when there is any peculiarity of structure, such as an oblique pelvis or pendulous abdomen, this should be mentioned, and the direction in which the pad is to press carefully noted. The vertical distance of the internal ring, from a line joining the two anterior superior spines, is often useful. In addition, full particulars must be given as to the size and nature of the hernia, the side on which it is situated, the muscular condition and the employment of the patient, and the age and sex.

**To test the truss,** the patient should be seated on the edge of a chair, with **knees separated so** that the structures around the rings are relaxed, and di-

rected to strain downward. If the rupture does not escape, the pad fits the opening and the spring is sufficiently strong. Too strong a one is injurious, and its pressure tends to cause absorption of the tissues beneath. For the first week the truss is generally exceedingly uncomfortable, but it must be worn all day, and, in some instances, at night as well, though a lighter one is sufficient then. In any case it should be adjusted in the morning while the patient is still lying down, care being taken that the hernia is completely reduced. If the skin becomes tender, it may be bathed with eau de Cologne and dusted with violet powder. Waterproof trusses, covered with india-rubber, are required for bathing.

Innumerable modifications have been devised for special herniæ. An excellent one consists of a semi-circular spring with a broad flat plate on the sacrum, and a movable pan over the protrusion; and it should be adjusted around the opposite side of the trunk. Pads filled with sand, or moulded on the spot itself, are often of use if the skin is tender and a water-pad is not available. Irreducible hernia may be enclosed in a hinge-cup, made of a rim-plate covered with leather, or supported in a laced bag truss, in the hope that the size may be diminished by the continued pressure. Belts may be required for umbilical or ventral protrusions. A skein of Berlin wool may be used for the congenital hernia of children, as described by Coates, of Salisbury. It consists of about twenty threads tied together at intervals to prevent their separating, with the loop-end of the skein placed over the abdominal ring; the other end is carried across the pubes round the opposite side behind the body, and brought down in the fold of the groin to pass through the loop; it is then taken between the thigh and the scrotum under the limb, and brought up behind it to be fastened to the horizontal portion. The loop, with the skein passing through it, forms a pad resting on the inguinal canal; the wool is sufficiently elastic to exert reasonable pressure, and cannot gall the skin Moreover, it can be renewed as often as required, and when it is thought that the truss may be left off the strength can be gradually reduced by diminishing the number of strands.

### Irreducible Hernia.

A hernia is irreducible when, without the circulation or the passage of fæces being impaired, it cannot be returned into the abdomen.

In a few cases this is due to changes in the tissues around or in the sac; nearly always it is the result of the condition of the rupture itself. The size may be the obstacle, as in large, neglected scrotal or umbilical herniæ. The shape may prevent it, especially if it consists of omentum; this assumes the form of an inverted mushroom, tough and fibrous at the neck, wide and expanded in the body of the sac. Much fluid renders it difficult, owing to the way in which it protects the intestine from manipulation; but this is usually only temporary, and can be easily removed by tapping. Adhesions are exceedingly common and are much more serious. They may form between the sac and its contents, or between the structures inside, so that they cannot change their relative position. Finally, in some cases it is due to anatomical peculiarities, such as the absence of a peritoneal covering, as in hernia of the bladder.

Irreducible herniæ, if left to themselves, tend to increase in size until almost the whole of the intestines may find their way into the sac. Even when they are small they cause extreme discomfort; dyspepsia, dragging pains, and colic are of frequent occurrence, especially after food, from interference with the movement of the stomach; when large, they become a serious source of danger. Constipation may lead to the accumulation of fæces, and this to obstruction; strangulation may occur, either gradually, as in consequence of obstruction, or suddenly, from the descent of a fresh portion. This is especially frequent in the femoral epiplocele of women; irreducible omentum is in them of common occurrence, and, from its giving rise to no serious symptoms, often receives no attention; but the band running down from the stomach to the crural ring acts as an inclined plane, which, as the intestines sweep round the peritoneal cavity, guides them infallibly

into the orifice. Besides this, an irreducible hernia is constantly liable to become inflamed, as, owing to its size, it is very much exposed to injury; and even rupture of the intestines or of the sac may occur from accidental violence.

**Treatment.**—This must be guided by the age and condition of the patient and the size and nature of the rupture.

Where the patient is old and feeble, not likely to undertake vigorous work, the hernia should be enclosed in a bag-truss, laced up on one or both sides, or in a cup made of soft leather supported by a metal rim. Sometimes, as suggested by Bryant (Fig. 374), the pad may be made of metal moulded on a cast taken from the hernia when it is at its smallest. In this way the rupture can always be prevented from increasing, and sometimes can be materially reduced in size.

In younger people, if the rupture consists of omentum only, an attempt may be made to reduce the size by procuring absorption of the fat. The patient should be confined to bed, on diet consisting very largely of lean meat; an ice-bag should be placed upon the swelling, and small doses of iodide of potash given. Sometimes under these conditions the size is so much reduced in the course of ten days or a fortnight that taxis succeeds under an anæsthetic; but the smallest adhesions are sufficient to prevent it. If this fails, a truss may be fitted over it, but if there is much inconvenience, either from this or from gastric trouble; or if the patient is, as most of them are in the lower classes of life, too careless to be trusted; or if they are likely to be placed in circumstances in which they could not at once obtain advice, it becomes questionable whether an operation should not be undertaken.

FIG. 374.—Pad and Truss for Irreducible Hernia.

Great difficulty is experienced sometimes with sailors, who have allowed an enterocele to attain an enormous size, and perhaps become extensively adherent, before applying for relief. In such a case, however, an operation should never be lightly undertaken; it usually involves prolonged dissection, and it may be found, after all, impossible to complete it.

## OBSTRUCTED HERNIA.

A hernia is obstructed or incarcerated, when, without the circulation being affected, the passage of the fæces is arrested, either from accumulation in the interior or from the impaction of scybala. This can only happen with large herniæ, and probably only with those that contain some portion of the colon; the contents of the small intestine are too liquid.

The most typical example occurs in the neglected umbilical herniæ which are so common after middle life in women who have had large families. A large pendulous mass hangs down over the edge of the umbilicus, sometimes tympanitic, but more often hard and uneven; generally speaking, it is not very tender, though it is often the seat of a griping pain, and the coils of intestine can be felt and even seen working in it. Constipation is complete, unless the sigmoid flexure and the rectum contain fæces: the tongue is thickly furred and inclined to be dry; the appetite is lost; nausea is common, though the patient seldom is actually sick; and, although there is great discomfort, and perhaps painful colicky spasm in the abdomen, there is an entire absence of the depression characteristic of strangulation. The danger is that the veins may become compressed, and the return of blood impeded, until the congestion passes into strangulation. I have known a patient suffer from an obstructed umbilical hernia on four occasions, at intervals of a few months: the last time the movements of the intestine suddenly ceased, and the patient began to sink; strangulation had set in.

**Treatment.**—Position in these cases is most important; so long as the hernia hangs down it is hard, tense, and often œdematous at the lowest part; when it is raised over the orifice from which it has escaped, it becomes soft and flaccid. This should be assisted by warmth and kneading day after day, so as to empty part of the bowel; the colon should be thoroughly evacuated with enemata; the diet small in quantity but fairly nutritious; and opium only given if there is severe pain; afterward the bowels must be kept relaxed until the size of the hernia is reduced again.

### Inflamed Hernia.

Irreducible herniæ, especially those containing omentum, may become inflamed from the pressure of an ill-fitting truss, from taxis, or other forms of injury; much more rarely from the impaction of fæces, or as a result of enteritis. In most cases the sac is empty, but the walls are thickened and softened; the endothelium disappears; in its place there is a roughened surface coated with lymph, and all the contents are congested, swollen, and œdematous. Sometimes the sac is filled with a turbid fluid. Suppuration, fortunately, is rare (unless the bowel is strangulated); nearly always the inflammation subsides, and the lymph becomes absorbed, leaving a few adhesions between the structures inside.

The skin over the sac is reddened, œdematous, and adherent to the fascia beneath; the pain is very severe, with marked tenderness on pressure; and the sac feels swollen and tense, but there is still an impulse on coughing, and sometimes in a large hernia the finger can be passed along the pedicle for some distance. The patient is ill and feverish, with nausea and abdominal tenderness, especially in the region of the sac; but there is no collapse; the face is not anxious or the tongue dry, and the pulse has not the small, wiry character characteristic of strangulation.

The treatment is the same as in local peritonitis; the patient must be placed in bed and kept on milk diet; small doses of opium may be given every few hours at first, then at longer intervals. An ice-bag should be placed over the swelling, until the temperature is reduced, but in old people it should not be kept on longer than this. Afterward, the bowels must be carefully regulated, and the hernia protected from further injury.

### Strangulated Hernia.

A hernia is strangulated when it is so tightly constricted that the circulation is stopped. The whole circumference of the gut may be caught; or only one side of a loop, as in Littre's hernia, so that the channel is not completely closed: or the intestine itself may be free, and the omentum only involved; the symptoms are essentially the same, though they differ in intensity.

**Causes.**—Strangulation may occur during perfect health, suddenly and without warning; in many instances, however, there is a history of some previous intestinal trouble, dyspepsia, diarrhœa, or colic; and it is possible that this increases the liability, either from the general malaise and want of tone in the abdominal muscles, or from the relaxed state of the mesentery.

The immediate cause is usually a sudden effort, lifting a heavy weight, or straining at stool with the thighs in such a position that the abdominal rings are relaxed and unprotected; but strangulation may be gradual, and it has been known to occur during sleep. Where there is a congenital sac, the hernia may be strangulated the first time it descends, and then, especially if the patient is a young adult, the effect is very characteristic: a loop of intestine is suddenly squeezed through a narrow channel into a wider space beyond, and the circulation is stopped at once. The same thing happens if the sac is an old one and the hernia has not descended for some considerable time, and very often these cases are the worst, from the unyielding nature of the tissues at the neck. When there is already an irreducible hernia, especially if it consists of omentum, and a fresh loop

ing to the condition of the hernia and the vigor with which taxis has been applied. When quite recent it is bright and clear; as the congestion increases it becomes blood-stained from the giving way of small vessels, especially if any force is used; and occasionally there are coagula. Flakes of lymph are sometimes present, and in the worst cases, when gangrene has set in, it is filled with pus of the most offensive description and mixed with gas. Occasionally, even when there is no perforation, there is a distinctly fæcal odor, just as there is sometimes in abscess of the abdominal wall.

A peritoneal sac is very rarely wanting, but in the case of the colon there may be only a partial one. Sometimes it is so thin that the contents can be seen through it without difficulty: in old cases, especially when a truss has been worn, it may be so thick that layer after layer of fibrous tissue is divided, under the impression that each is the last. In a few instances portions of the subserous fat still retain their connection with it, so that it has a deceptive resemblance to omentum. In recent hernia it can be isolated from the structures around; in old ones, however, it is closely incorporated with them, especially at the neck.

FIG. 377.—Extreme Venous Congestion and Interstitial Hemorrhage, the Effects of Severe Strangulation of the Bowel.

The tissues outside the sac may be unaltered; but not unfrequently they are bruised or inflamed from the severity of the taxis. When the contents of the sac are gangrenous and suppuration has set in, the appearances are simply those of an abscess.

**Symptoms.**—The symptoms of strangulation are collapse, vomiting, and pain. Where the patient is young and in vigorous health, and where the strangulation is sudden and complete, the symptoms begin instantaneously and with great severity; where, on the other hand, the patient is feeble and anæmic, or where there is already a large epiplocele protecting the intestine from too great pressure, they set in very gradually, and some hours may pass before they reach their full intensity. In addition, it is not improbable that the part of the intestine involved is of some importance. The collapse and the vomiting are due, entirely at first, to the effect of the strangulation upon the nerves, especially upon the great plexuses in the abdomen, and, though, perhaps, to a less extent, this is true of the pain as well. It is not improbable, as Treves has pointed out, that the jejunum with its muscular walls, copious blood supply, well-developed nerve plexuses, and vigorous functional activity, would resent an injury more energetically than the lower

ileum, where the muscular tissue is more scanty, the blood supply less free, and the functional activity less pronounced.

*The aspect of the patient* changes almost at once. The face is drawn and pinched, the cheek blanched, the lips white, the eyes sunken and surrounded by dark rings, and the forehead covered with perspiration; the patient looks prematurely old, and the expression is that of intense distress. The skin, especially on the extremities, is cold, the temperature is subnormal, and the pulse small, feeble, and compressible, often as many as 120 and even 140 beats in the minute. The tongue at first is white, but it soon becomes dry and brown; there is intense thirst, and the amount of urine secreted is far below normal. Like the other signs of collapse, this is due to the disturbance of the abdominal nerve-plexuses, and is acute in proportion to the extent to which they are involved.

*Vomiting* may come on at the moment of strangulation, or not until later. When it has commenced it rarely ceases, its character gradually changing as the contents of the stomach, duodenum, and small intestine are successively ejected. At first it may consist of undigested food; very soon it becomes bilious in character, and, after three or four days' strangulation, it comes up in great gushes, a dark-brown, muddy liquid, intensely offensive in odor, sometimes distinctly fæcal. It is probable that the peristaltic action of the intestine is reversed, although apparently in intestinal obstruction, when the proximal part of the intestine is thrown into violent colic, the contents, even of the ileum, can be ejected without.

*Pain* varies considerably. In some it is local, and comes on at the moment of descent, caused by the stretching of the tissues around the sac, and when the strangulation is sudden it may be very severe. In others it is scarcely noticed, and the patient may be almost unaware of the existence of the rupture. A fixed, dragging pain, referred to the umbilicus, is nearly always present, probably due either to traction on the mesentery or to the effect upon the great nerve-plexuses. Besides these there are usually wandering colicky pains all over the abdomen, caused by the violent and irregular movements of the bowels above the strangulation, and made worse by any attempt at taxis.

*Constipation* is nearly always present, caused not by the obstruction, but by the effect upon the nerves, for even when the sigmoid flexure is full the bowels are rarely opened after strangulation has set in. Exceptions to this, however, sometimes occur, and there may be one or two motions when the lower bowel is full.

In Littre's hernia the interior of the intestine is sometimes closed by the kinking opposite the strangulation, but often it is patent all the way through. Constipation, however, is the rule in this as well as in other forms, although in a few cases (three out of fifty-three) Treves found that there was diarrhœa, and in several of the others the bowels responded to aperients.

The local symptoms are generally very prominent, but occasionally the patient is not aware of the existence of a hernia, although it may have been in a state of strangulation for forty-eight hours. Obturator and sciatic herniæ especially are so small and so deeply placed that the tumor often cannot be made out, even after careful examination. If the hernia is an old one, that has been down many times, the size is likely increased, but it may be impossible to obtain exact information.

Small herniæ, when strangulated, are hard and tense, or doughy if they contain omentum; large ones, especially those that are irreducible, are often fairly soft, as the strangulated part may be simply a loop at the back covered in by the rest. In many cases the tumor is dull on percussion, although it contains intestine, partly because of the liquid in the sac, partly because the amount of air is so small and the walls so thick.

*Absence of impulse* on coughing or straining is the chief local feature; the contents of the sac are shut off from the abdomen, and nothing more can enter. In large hernia the impulse can sometimes be felt as low down as the neck, there it ceases abruptly. The skin may be tender, but, as a rule, this is not marked unless the sac is inflamed or taxis has been too vigorous.

As the case progresses and gangrene becomes imminent, the constitutional

symptoms grow more distinct. The vomit is intensely offensive, or dark, like coffee-grounds, and it comes without effort in great gushes; there is constant and painful hiccough, the pulse becomes intermittent, the abdomen begins to swell and become tympanitic; it is not very painful as yet, but the whole surface is tender; the mind begins to wander, the face becomes more haggard, the patient tosses restlessly about, growing colder and colder, and at length sinks exhausted. Occasionally, before the end, the local pain ceases, the tenseness of the tumor disappears, and it slips up almost of itself, making the abdominal symptoms tenfold worse. More frequently the swelling increases, and becomes resonant as the gases of putrefaction collect; the skin becomes livid and œdematous, and at length gives way, allowing the intensely fœtid contents to escape externally, and leaving, if the patient survives, either a fæcal fistula or an artificial anus.

It very commonly happens, especially in an irreducible femoral epiplocele, that after the sac is laid open, nothing but omentum is found, although the symptoms of strangulation may have been well marked. It is possible that in some of these a small knuckle of intestine has been strangulated behind the rest, and reduced by taxis before the operation, without its having been noticed; the size is small, and it may be quite concealed, but there is no doubt that strangulated omentum can give rise to the same symptoms as intestine, though less marked and less acute. The pain is not so severe or the vomiting so constant; constipation is less complete and the constitutional symptoms are milder. The local distress is also inconsiderable, the tumor feeling harder, and permitting manipulation more freely than when it contains intestine. As time progresses, however, the symptoms become as severe as in other forms. The same thing has been known when only peritoneum was involved.

The time that elapses before gangrene or ulceration of the mucous membrane occurs is very variable. Erichsen mentions a case in which the vitality was destroyed in eight hours; in other instances the intestine may recover even after five or six days. It depends, to some extent, upon the kind and size of the hernia and the tightness of the constriction, but there is no doubt that a great deal of the injury inflicted on the bowel is due to ill-advised and violent taxis.

Symptoms of an almost identical character may be caused by other conditions of the bowel. Internal hernia and strangulation by bands or through apertures, are, of course, really the same; the seat of strangulation differs, and that is all, but very acute symptoms may occur in volvulus, acute intussusception, stricture and impaction of fæces or gall-stones, sometimes with, sometimes without previous warning. The real cause of the symptoms is the effect, not upon the blood-vessels (though this forms a convenient standard to judge of the vitality of the tissues), but upon the nerves of the peritoneal covering, and this is borne out by many isolated facts. I have met with cases of external hernia in which all the symptoms of strangulation were well marked without the bowel being either very tightly gripped or deeply congested; and the same thing has occurred from the simple retention of the bowel in a colotomy wound (Davies-Colley), and from hernia of the subperitoneal fat dragging upon the peritoneum.

**The Diagnosis of Strangulation.**—Inflamed and obstructed irreducible herniæ are occasionally attended by symptoms resembling those of strangulation; there is constipation with pain, and perhaps vomiting, but this never attains the persistence or the character of the sickness of strangulation; there is no collapse, and an impulse on coughing can always be detected.

Acute peritonitis is more difficult; the vomiting may be persistent and very offensive, the patient may be in a state of extreme collapse and the bowels absolutely confined. In such a case the diagnosis must rest chiefly upon the absence of relation between the sac and peritonitis, and upon the physical character of the hernia itself.

A few cases are recorded in which the vomiting of pregnancy and that which sometimes attends the late descent of a testis have been mistaken for that of strangulation. In all cases of doubt an operation should be performed.

**Treatment.**—The strangulation must be relieved either by taxis or by operation with the least possible delay.

1. *Taxis.*—The method depends upon the anatomy of the part, but the principle is the same in all. The structures around the hernia must be relaxed as far as possible, the neck of the sac must be steadied with one hand, sometimes, as in the inguinal variety, pulling it slightly down so as to straighten it out, and then the gentlest pressure used, squeezing it a little from side to side, and kneading it carefully with a view of emptying the hernia of some of its contents, or of returning the piece of intestine that came down last. Intestine slips up with a sudden rush and the patient experiences complete relief at once; omentum does not disappear quite in the same way, but as it yields it leaves behind it a distinct sense of something gone.

Of all the aids to taxis there is only one, an anæsthetic, that can always be relied upon, and that one may only be used when, should taxis fail, everything is ready for immediate operation. It is manifestly unfair to the patient to expose him a second time, with a short interval, to the depressing influence of an anæsthetic, and to run the risk of making the vomiting and the other symptoms worse in the meantime. Morphia may be given to quiet a very restless patient and prevent exhaustion, but it is of no help in other ways, and great care must be taken that the symptoms of strangulation are not obscured by it without the constriction being relieved.

An ice-bag, or Leiter's coil with ice-cold water, is of some use if applied within a short time of the descent; the bulk of the mass is reduced, and occasionally, if taxis is tried then, it succeeds almost at once, but cold is not advisable for old people with feeble nutrition, or where the hernia has already been cut off from the circulation for some time, for fear of accelerating gangrene. Over omentum it has much less power. A hot bath may be used in large inguinal herniæ if there is much spasm and the patient cannot leave off straining; but it must not be forgotten that a bath of the temperature of 100° F. or 102° F. kept up for half an hour may cause very great depression.

From time to time other aids are recommended for special cases. Inversion of the patient, for example, raising the pelvis well above the shoulders, so that the intestines gravitate toward the diaphragm, is highly spoken of in some cases of large inguinal hernia. Care must be taken to keep the hips well flexed if it is tried. Aspiration of the intestine is exceedingly risky, but the fluid in the sac may sometimes be drawn off with a trocar and cannula with advantage. Enemata should never be used, and purgatives are the worst things possible.

Taxis is more liable to succeed with an inguinal than with a femoral hernia; the constriction in the one is muscular, in the other mainly ligamentous; but the tension of the obliquus externus has an immense influence upon the size of the crural ring; if the finger is placed in the canal while a patient is straining or vomiting, Poupart's ligament descends upon it with immense force. In the same way taxis is more successful in acquired inguinal hernia than in the congenital form, but here the length and obliquity of the neck are additional reasons. Very small and very large herniæ and those which are tense and hard are more difficult of reduction, other things being equal, than those which are lax and moderate in size.

*Accidents from Taxis.*—Taxis is responsible for a very large proportion of the fatal results of hernia. The bowel is intensely congested; its walls are rigid and almost solid with blood; it is prevented from returning by a constricting ring with an edge sometimes almost as sharp as a knife, and over which it bulges in all directions; the vitality of the tissues is seriously impaired; no fresh blood has passed through it for hours or even days; and while it is caught like this an attempt is made to force it through. Sometimes by careful attention to position, and by using every endeavor to relax the tissues, the ring may be so widened that some of the blood in the walls or of the gas in the interior is squeezed out, and then the rest may follow; but if the congestion is severe and the walls rigid and

solid, it is impossible for them to yield sufficiently, while, on the other hand, they bruise with the greatest ease. Even when the constricting band is divided and manipulation applied directly to the intestine, and to the proper end of the loop, not indiscriminately to the outside of the tumor, reduction is often very difficult; and I have heard of a case in which it was necessary, although the neck of the sac had been freely incised, to open the abdomen and make use of traction from the interior.

Bruising of the skin and cellular tissue, ecchymoses in the walls of the intestines or in the omentum, and hemorrhages into the bowel or the sac, are common results of taxis, and often cause inflammation. Other consequences, not so frequently met with, are more dangerous; rents in the serous coat, for example, rupture of the bowel, bruising to such an extent that sloughing ensues, and injuries of the sac, which may lead to the serious mistake that the hernia has been reduced while the strangulation still persists. Of these last the two most common are *reduction en masse* and *rupture of the sac*. It is, however, only fair to say that in the majority of instances they have been the result of the patient's own violence.

In the true reduction *en masse* (Fig. 378) the sac is separated from its surroundings, and with its contents still unreduced, is pushed bodily into the subperitoneal space. It can only occur in tolerably recent herniæ, in which the sac is not adherent, and is most common in the direct inguinal form. But it may be imitated easily in femoral hernia if the sac is freely separated from the tissues around and an attempt made to reduce the contents without opening it; suddenly the whole may slip through the crural ring into the abdomen.

The extent of the displacement is not so great in the other forms. In one (Fig. 379), which appears to be more common in congenital inguinal hernia, the neck of the sac only is detached and forced in (carrying with it the strangulated portion of intestine), while the rest still protrudes in the inguinal canal; in another the sac is hardly detached at all; but the unreduced intestine is so pushed up the canal, sometimes into a kind of diverticulum lying between the peritoneum and the fascia transversalis, that reduction is complete, so far as external appearance is concerned (Fig. 380). These diverticula may either be formed at the time by partial displacement of the sac, or they may be congenital, and then they frequently attain a very large size.

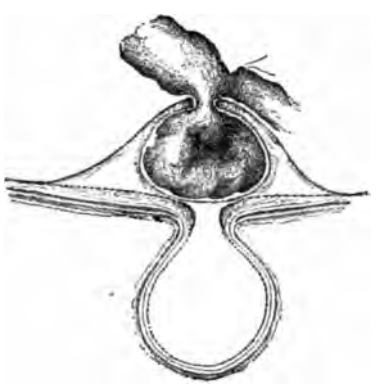

FIG. 378.—Reduction *en masse*, the Sac entirely detached from its former site (as shown by the dotted line), and pushed into the Subperitoneal Tissue.

Rupture of the sac may be associated with this, or it may occur independently (Fig. 381). The rent usually lies upon the posterior aspect, near the neck, and the intestine is gradually squeezed out through it into the subserous tissue.

The symptoms in all of these are very nearly the same. The contents of the sac do not slip back, they are gradually pushed to one side, leaving a certain degree of fullness over the neck; sometimes even a distinct tumor can be felt, dull on percussion, and very painful. In a few cases the mass has been felt repeatedly returning into the abdomen with the least pressure and descending again as soon as the patient coughed or strained, but not disappearing altogether. The constitutional symptoms, so far from being relieved, are generally made a great deal worse by the injury inflicted upon the contents.

If any of the conditions is suspected, the sac must be exposed and opened at once. The incision may be made in the ordinary situation, or, if the tumor cannot be distinctly felt, in the middle line; all the ordinary apertures can be easily explored from this. The neck must then be divided freely, the bowel drawn out

and examined, and the finger passed well up into the abdomen and down to the bottom of the sac, so as to make sure the condition is relieved.

In a few instances an omental sac, with the bowel strangulated in it, lies inside the peritoneal one, and it is possible that this may be reduced bodily, intestine and all, into the abdomen. If this occurs the symptoms persist in the same way, and the abdomen must be opened to ascertain the cause, as in other cases of internal hernia.

Taxis, even when successful, is sometimes followed by serious consequences. Of these the most common is *peritonitis*; the intestine is either inflamed at the time of reduction or becomes inflamed after being so long anæmic, and allows infective irritants to work their way into its walls. *Suppuration* and *sloughing* may set in, or *adhesions* form, binding down the bowel, or *stricture* may develop from the injury the coats have sustained. Sometimes a patient progresses favorably for three or four days and then sinks suddenly into a state of *collapse*, from the separation of a small gangrenous patch, and death may occur from *shock*, especially in the case of stout, middle-aged women, whose circulation is already embarrassed. I have known this happen on several occasions in which, as an anæsthetic was not administered, nothing else could have been held responsible.

The length of time taxis may be applied before further measures are resorted

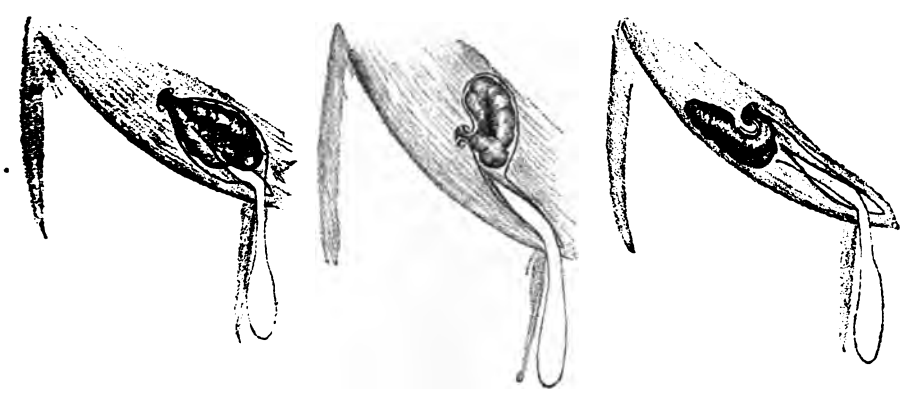

FIG. 379.—Reduction into the Canal. FIG. 380.—Intraparietal Hernia. FIG. 381.—Rupture of the Sac.
Three different varieties of Imperfect Reduction.

to cannot be laid down in an absolute manner; it depends upon the size and kind of hernia; whether it is tense or lax; how long it has been down; whether any previous attempts have been made, and whether there are any signs of inflammation. If there is a small tense knuckle of intestine lying in the crural canal, without any impulse on coughing, and if it has just descended, a single trial may be made, and then an ice-bag laid on the swelling for four or five hours. If at the end of that time it appears unchanged, and does not yield at once, the patient should be placed under an anæsthetic and herniotomy performed. If the symptoms are very acute, indicating a severe degree of strangulation, as, for example, in congenital inguinal hernia in young adults, even this is not advisable; it is better, for the sake of the intestine, to give an anæsthetic, and if, when the muscles are relaxed, a very brief attempt does not succeed, operate at once. On the other hand, a large scrotal or umbilical hernia, the contents of which are soft and lax, consisting largely of omentum and without acute symptoms, may be manipulated with considerable freedom. If the skin over the hernia is red or tender; if the strangulation has lasted for two days acutely, or three under any circumstances; if the constitutional symptoms are severe; or if there is the least suspicion as to the condition of the intestine, taxis should not be employed at all.

The subsequent treatment, if the intestine has been strangulated, requires as

much care as after an operation. A spica or a truss must be applied at once to prevent the descent of the rupture again; the patient must be placed in bed; no food allowed for twenty-four hours, and nothing but a little ice until the vomiting from the anæsthetic has ceased; and a hypodermic injection of morphia or some tincture of opium should be given to keep the intestine at rest for at least forty-eight hours.

*Herniotomy or Kelotomy.*—If taxis fails, or it is not thought advisable to try it, the constriction must be divided.

The patient is placed under an anæsthetic, with the shoulders slightly raised and the knees flexed; and the skin shaved and thoroughly cleansed. The incision is over the neck of the sac; in inguinal hernia, over the external ring in the direction of the canal; in femoral, over the upper part of the tumor immediately below Poupart's ligament; and the tissues between the skin and the sac are divided layer by layer until the outer wall of the latter is reached.

In recent herniæ the sac is readily recognized. It has a bluish appearance, like a thin-walled cyst, and is covered with a layer of loose cellular tissue, devoid of fat; and, unless adherent, it can usually be thrown into folds and made to move over the subjacent structures by pinching it up with the forceps. In other cases the intestine, or the yellow fat of the omentum, can be seen through it, so that there is no doubt when it is reached. In old herniæ, however, over which a truss has been worn for years, the difficulty may be very great; the sac may be thick, dense, and fibrous, so that layer after layer is divided, each one apparently the last; or it may be so closely adherent to the structures around that its definition is impossible. Sometimes there is a cyst lying over it (generally a bursa) which may be opened by mistake; or, as in encysted or infantile hernia, there may be a definite peritoneal sac in front. The difficulty is especially serious when the sac is flaccid or empty, or surrounded by subserous fat; under these conditions, especially if it has been bruised by taxis, it may resemble congested omentum very closely. In other instances it does not contain any fluid, or the intestine is adherent to its inner surface over the front, so that it is in danger of being wounded; and, what is perhaps most serious of all, the sac may be partially or entirely wanting. In this case (which rarely happens except with the bladder and some portions of the colon), the hernia rapidly forms adhesions to the cellular tissue around, and, unless the muscular wall is recognized as it is approached, there is great danger of its being incised by mistake.

In certain cases—large scrotal or umbilical herniæ with subacute symptoms—the attempt to reduce the hernial mass *en bloc* should be made, though in the latter it is not likely to succeed, owing to the extraordinary thinness of the walls; there is considerable danger in exposing a large quantity of intestine to cold or to the irritation of sponging; but it should never be thought of in small herniæ with acute symptoms; in those of a mixed character—entero-epiploceles, for example—as there might be an omental sac inside; or in any case in which, either from the condition of the skin, the history, or the constitutional signs, there is the slightest suspicion as to the state of the contents. If the operator has decided upon opening the sac, it should be done before dividing the constriction outside, for fear of a piece of intestine slipping back unawares.

Great care is needed while opening the sac to avoid injury to the structures beneath. Part of the wall should be pinched up with the dissecting forceps, and opened with the knife on the flap, not cutting toward the interior. Fluid usually escapes at once. A director should then be introduced into the opening, and the sac freely divided up to the neck.

The subsequent proceedings depend upon the condition of the contents. If there is intestine and it is not seriously injured, the stricture is divided and the hernia returned at once. The incision is made in the same way, whether the seat of strangulation is outside the sac and is divided without opening the latter, or whether it lies in the neck; either the finger nail, or a flat director, is insinuated under the margin of the band (and often it is so tight that this is a matter of con-

siderable difficulty) and then a hernia knife or a blunt-pointed bistoury, with the greater portion of the edge protected with wrapping, is gently slipped under, and a very small incision made, without any cutting, simply by the pressure of the blade. As soon as this is done the difficulty disappears: the nail can be introduced more easily, and either the original wound enlarged, or, what is far to be preferred, two or three small ones made. Large incisions are not only more likely to injure adjacent structures, such as an abnormal artery, but weaken the abdominal wall and lead to a very intractable form of hernia. Care must be taken, when the sac is opened, that the intestines do not bulge upward by the side of the director and get in the way of the knife; it is to prevent this that the hernia director is especially broad.

FIG. 382.—Method of Dividing the Constriction.

Occasionally, as already mentioned, there is some difficulty in reducing the intestine after the stricture has been divided, owing to the thickness and rigidity of the walls; but this may generally be overcome by applying taxis first to that end of the loop which was the last to descend. If this fails the intestine may be drawn slightly downward; so long as reasonable care is used this may be done without fear, as the difficulty only occurs when the walls are unusually firm and solid. Aspiration of the bowel should not be attempted.

The condition of the intestine, whether it is fit to be returned into the abdomen or not, is determined by its consistence and color. If it is soft and flabby, instead of firm and resilient, if there are ashy-gray or green spots upon it, or if the fluid is turbid and very offensive, it certainly is not. The difficulty is greatest where the intestine is almost black, and has lost its lustre, or is coated over here and there with flakes of lymph, or where, without any evidence of gangrene, it shows that it has been very tightly constricted; undoubtedly it stands a better chance of recovery inside the abdomen than if it is left in the sac; on the other hand, it is almost sure to set up a certain degree of peritonitis. Probably in this case it is best to return it, having first passed a catgut loop through the mesentery, so that it may be retained near the orifice. Possibly then, if sloughing does set in, adhesions may form around and fæcal extravasation be prevented.

[When there are evidences of inflammatory action in the loop of intestine, it is well to irrigate it with a warm antiseptic solution before returning it.]

Where the condition of the bowel is hopeless, it may either be left *in situ*, so that if the patient survives an artificial anus is formed, or it may be drawn down at each end until the whole of the gangrenous part is exposed, resected, sutured and returned. Which of these methods should be adopted depends upon the circumstances of each case; as a rule the patient is too feeble and exhausted to stand so prolonged an operation as enterectomy, and in femoral hernia, in which gangrene is most common, there is the serious objection that it practically entails division of Poupart's ligament. If the intestine is kept *in situ* the stricture should be interfered with as little as possible and the adhesions around the neck of the sac should not be touched; they are the only safeguard against a certainly fatal peritonitis. The wound should simply be left wide open; as the congestion and swelling subside the fæces find their way out through the upper orifice, and either a fæcal fistula or artificial anus is formed. Peritoneal rents in the coat of the bowel should be sewn up with catgut. A pin-hole perforation, if the surrounding part is healthy, may be treated in the same way.

Recent adhesions, unless the intestine is gangrenous, can be broken down with the fingers; older ones, if not too extensive, may be dissected off. In large irreducible herniæ, however, this is often impossible without endangering the bowel; and the rupture must be left *in situ* after the strangulation has been re-

lieved. Later, when the wound has healed, the hernia may be fitted with a suitable truss.

Omentum must be thoroughly unraveled before anything is done with it; a small knuckle of intestine is often concealed behind it or in its substance, and may be easily overlooked. If it has only recently descended and is not congested, it may be returned; but if it is old and fibrous, or if it is already much injured, it should be secured with a clamp or forceps, cut off and ligatured bit by bit. As soon as it is certain that there is no risk of hemorrhage, the end should be returned well within the peritoneal cavity; if it is left at the neck of the sac it does not act as a safeguard and plug the opening, but encourages the descent of a fresh portion by guiding it to the weakest spot, and, by leaving a band extending from the stomach to the groin, exposes the patient to the danger of internal strangulation. [Some operators stitch the omentum to the peritoneum on the inside of the internal ring, in order to have an additional safeguard against recurrence.]

The wound in the sac, after the contents are reduced, must be treated in the same way as other wounds of the peritoneum; but in addition to closing the orifice into the peritoneal cavity, an attempt should be made to strengthen that part of the wall so that the descent of another hernia at the same spot may be prevented. [In all cases where a strangulated hernia has been operated upon, it is well to close the ring, and conclude the operation as would be done in an operation for radical cure.]

When the intestine is gangrenous no attempt should be made to close the wound. In other cases it should be thoroughly cleansed, dried, and sutured with catgut, leaving a drain at the most dependent orifice. An absorbent dressing should then be carefully packed over it, so that the sides are pressed together, and a bandage applied over this. The tube should be removed the next day to clear it of any coagula, and, if need be, introduced again through the superficial part of the wound. Afterward the dressing need not be disturbed until the wound is sound.

No food should be allowed for twenty-four hours, only a few fragments of ice to allay thirst; but if the patient is collapsed and the pulse failing, small quantities of brandy with soda water, a teaspoonful at a time, may be given at frequent intervals, until the skin is beginning to grow warm again. Meanwhile hot flannels and hot-water bottles should be placed all round, and every effort made to maintain the temperature. As soon as consciousness returns, one-third of a grain, .02 gramme, of morphia should be given hypodermically to check peristalsis, and if the bowel was much injured, or if from the purgatives the patient has taken there is any fear of diarrhœa, small quantities of opium must be given two or three times a day until the danger is past. Milk, beef-tea, and arrowroot may be allowed after twenty-four hours, provided there is no sickness, and at the end of four or five days, if all goes well, a little custard or fish. If the bowels are left to themselves they are usually opened as soon as the patient begins to take solid food, at the end of five or six days; or, if not, an enema may be given. In many cases they remain confined for much longer periods without causing any distress. [Opiates must be given with caution and only in case of necessity. Their frequent administration leads to ballooning of the intestines from tympanites, which not only adds to the patient's distress, but greatly disturbs the vital processes by mechanical pressure].

Death may be due to *shock* or to *exhaustion*, especially if, owing to the purgatives that are so often taken before advice is sought, diarrhœa begins as soon as the hernia is reduced. In most cases, however, the immediate cause is *peritonitis;* the symptoms that were present before the operation persisting, and growing worse, until collapse sets in. The intestine may have given way, causing fæcal extravasation; or the coats of the bowel, after being so long deprived of blood, may have become inflamed, as soon as the circulation was restored; or their vitality may have been so impaired that, without actual rupture, infective material can pass through them into the peritoneal cavity; or the contents

of the sac may have been septic at the time. In any case the symptoms are characteristic.

The patient lies with the knees and hips flexed; the peculiar haggard and anxious aspect on the face continues and grows more distinct; there is not, when the effects of the anæsthetic wear off, that expression of relief significant of successful reduction; the tongue remains dry and brown; the pulse becomes more rapid and thready; the vomiting and constipation persist; the temperature may rise a few degrees, but very commonly, especially when there is gangrene, it either remains stationary or becomes subnormal; and the patient, overcome by septic poisoning, falls into a semi-unconscious state, resembling typhoid. Sometimes the abdomen is distended, firm, hard, and intensely painful when touched, while the respiration is confined to the upper part of the thorax; more frequently, although the surface is always tender, the collapse is so profound that there is no complaint of pain; and the abdomen, although its walls are tense from the contraction of the muscles, is empty rather than distended, and moves a little when the patient draws a deep breath. In such a case it is usually found *post-mortem* that there are flakes of lymph upon the serous membrane, and no adhesions; nothing but an intensely irritating, semi-purulent, and turbid fluid.

In other cases the symptoms of strangulation, the vomiting, collapse, and constipation persist, it may be, for one or two days, before peritonitis sets in or the first stage is reached; and then it becomes a question whether the strangulation has really been relieved, or whether there may not be some further cause which has not yet been ascertained. Reduction *en masse* may have occurred, or the intestine may have been incompletely reduced; slight volvulus, owing to the elongation of the mesentery, may have followed; or there may be a second hernia, either external, at some other of the abdominal openings, or internal, through the omentum, perhaps; or, finally, the strangulated portion of intestine, without becoming gangrenous or setting up peritonitis, may have been so injured that it is no longer capable of doing its work (*ileus paralyticus*). In such circumstances there should be no hesitation in exploring the abdomen; it is the only course left; if any tumor or hardness can be detected, as in reduction *en masse*, the incision should be made over it; if there is no guide, the abdomen should be opened in the middle line, the seat of the original operation examined first, then the other situations in which hernia commonly occurs, and if this does not reveal anything, the collapsed intestine, below the injured part, must be found and traced upward until the cause is ascertained.

Care must be taken not to mistake the vomiting that arises from the anæsthetic for that which is due to the persistence of strangulation. As a rule, there is little difficulty, for even when it continues for more than a few hours, and is not checked by giving small fragments of ice to suck, or by warm applications to the abdomen, it is never offensive or fæcal in character, it does not come up in great gushes, and the retching is much more severe.

**Sequelæ.**—Strangulation of intestine may be followed by after consequences of a more or less serious description.

*Local peritonitis* is very common and is often preservative. The intestine, after reduction, has become inflamed, or may have sloughed and adhesions formed around it to prevent the extravasation of fæces; but this may lead to serious results at a later period. The intestine may be tied down in a loop; or it may be dragged upon at one spot until it forms an angle in the interior, obstructing the passage of the contents; or the peritoneum may be so thickened that peristalsis is rendered difficult; and even stricture may result.

In other cases *stricture* is due to the injury sustained by the mucous membrane. It ulcerates opposite the sharp edge of the constricting band, especially in femoral hernia, and after reduction, when it cicatrizes, it sometimes narrows the canal to a very serious extent.

*Volvulus*, or twisting of the intestine, causing very acute symptoms, sometimes

happens, the regularity of the movements being broken and thrown out of order by the elongation of the mesentery and the formation of adhesions.

When gangrene sets in and the contents of the bowel are discharged externally, either an *artificial anus* or a *fæcal fistula* is formed, according to the extent of the slough. If it is the whole circumference of a loop, so that the two ends

FIG. 383.—Stricture of the Small Intestine after Strangulated Hernia.

open on the surface side by side, it is an *artificial anus;* if, on the other hand, only one side gives way, so that the fæces in part find their way externally, in part follow the natural route, it is a *fæcal fistula.* In a few instances a communication has formed between two loops of the bowel, inside the abdomen—a *fistula bimucosa.*

## SPECIAL HERNIÆ.

### INGUINAL HERNIA.

Inguinal hernia protrudes through one or both abdominal rings. There are two classes: the external, oblique, or indirect, the neck of which lies outside the deep epigastric artery; and the internal, or direct, the neck of which lies to the inner side.

#### 1. *Oblique Inguinal Hernia.*

In this the intestine enters the internal ring, passing in front of the deep epigastric artery, and lies in the inguinal canal, in front of the spermatic cord. If it does not emerge through the external ring, it is called a *bubonocele;* if it project it is *complete,* and if it descend sufficiently far it is *scrotal* or *labial,* according to the sex.

The sac may be congenital or acquired; in the former case the bowel lies in the tunica vaginalis, which has either not been closed or has been forced open again; in the latter a new sac is formed out of the peritoneum covering the internal ring.

*a. Congenital Inguinal Hernia.*—The peritoneum which lines the lower part of the abdomen in the fœtus, and that which is attached to the gubernaculum testis, descend with the testis between the eighth and ninth months, the testis and peritoneum coming down together, or the pouch preceding the testis. This process of peritoneum is the tunica vaginalis; at birth it very commonly communicates with the general cavity, and it may continue to do so for a few months or even for the whole of life, though the opening may be so small as only to admit serum (congenital hydrocele). As a rule it becomes obliterated, first at the internal ring, then immediately above the testis, leaving an isolated sac in between, and finally this disappears. The right testis descends later than the left; often it does not reach the scrotum until the ninth month; and consequently the changes that

ike place about the inguinal canal, are later on the right side. For this reason, nd because of the lower attachment of the mesentery on the right, congenital nguinal hernia on the left side, by itself, is very rare; it may, and very com-ionly does, occur on both; but if it is met with on one only it is almost sure to e the right.

Hernia into the tunica vaginalis is called congenital, because of the condition f its sac. Naturally it is frequently met with at, and shortly after, birth; but it ay not occur until adult years; and the pouch may remain open for the whole f life without the intestine ever entering it.

There are two varieties of congenital hernia, depending upon the mode of losure of the canal:—

1. When the tunica vaginalis is open the whole way down, so that the intestine an descend as low as the testis and come into contact with it (Fig. 384).

2. When the sac is closed above the testicle. In this case the hernia descends nto the funicular portion of the tunica vaginalis only, and rests upon the top of ie testicle without touching it (Fig. 385). Occasionally the closure at this point

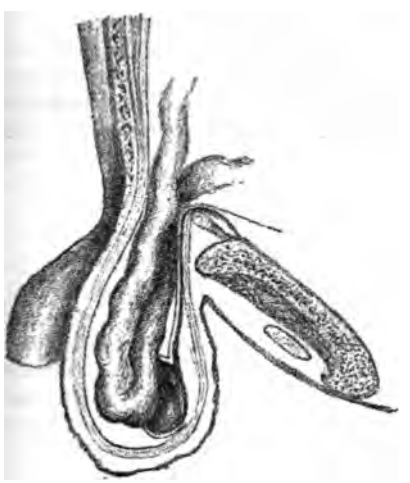

FIG. 384.—Congenital Hernia into the Tunica Vaginalis testis. The intestine and testis in contact.

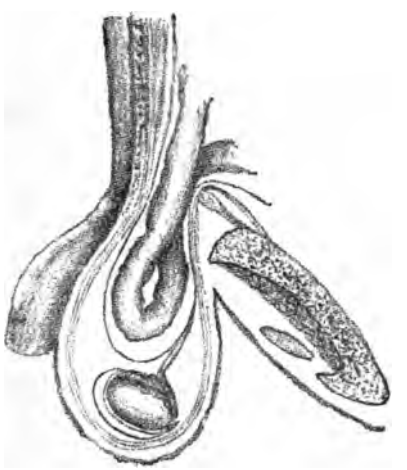

FIG. 385.—Congenital Hernia into the Funicular portion of the tunica vaginalis. The same diagram would answer equally well for an acquired hernia.

incomplete; there is a constriction, but nothing more, so that if a hernia de-ends and passes down to the bottom it assumes the shape of an hour-glass.

Congenital inguinal hernia is also common in female children, the protrusion ssing down in the canal of Nuck; and is sometimes met with in adults, consti-ting the ordinary form of labial hernia.

(*b*) *Acquired Oblique Inguinal Hernia.*—This is rare before adult life and is ich more common among men than women. It enters the internal ring, adually pushing the peritoneum in front of it, forming a bubonocele first, and en becoming complete. Its progress, therefore, is gradual, while that of the ngenital variety is rapid and sudden; in course of time it may attain a very ge size, and by its weight drag one ring so near the other that the inguinal nal, as such, is destroyed, and the rupture appears to come directly out of the domen.

There are two varieties, one exceedingly rare; the other, the most common all, depending upon the size and relation of the tunica vaginalis.

1. It occasionally happens that the tunica vaginalis is closed at the internal ig and nowhere else, so that there is a great pouch of peritoneum investing the

testicle below, extending up the inguinal canal, and only shut off from the abdomen by a thin septum. If an oblique hernia develops under these conditions, a fresh sac is pushed down either behind this or into it (invaginating it), so that when the intestine is exposed by an incision from the front three layers of serous membrane are divided —the anterior and posterior walls of the tunica vaginalis and the anterior wall of the hernial sac. This is the *infantile hernia* of Hey (Fig. 386). The encysted hernia of Astley Cooper is probably the same; the cicatricial septum which was supposed to stretch across the orifice of the canal having been shown by Lockwood to have no existence.

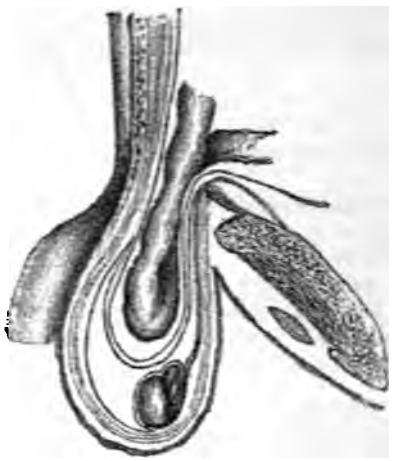

FIG. 386.—Infantile Hernia.

2. In the other, the common form of acquired oblique hernia, the tunica vaginalis is in no relation with the peritoneal sac. A fresh one is formed, which generally descends in front of the spermatic cord, but occasionally in its substance, and the testicle is at first below, then below and behind the hernia, becoming more prominent as the sac grows tense.

### 2. *Direct Inguinal Hernia.*

In this the protrusion usually takes place through the structures that lie immediately behind the external ring, the conjoined tendon and the triangular ligament being stretched or split; occasionally, however, the neck of the sac is higher up, on the outer side of the obliterated hypogastric artery, between it and the epigastric, and the hernia lies, for a very short part of its course, in the canal. The coverings are the same as in the oblique form, except that the conjoined tendon (when it is not split) takes the place of the cremasteric fascia. The cord, however, lies more to the outer side of the sac; the hernia is usually smaller and more globular, and, after it is reduced, the finger seems to pass straight into the abdominal cavity.

**Diagnosis.**—Inguinal hernia must be distinguished from:—

1. Swellings in front of the inguinal canal, such as *enlarged glands*. These may be recognized by their relation to the external ring. If the tip of the forefinger is placed at the bottom of the scrotum and pushed upward, invaginating the skin, behind the spermatic cord, it rests first upon the front of the pubes, then on the ring itself; and the swelling, if it is a gland, can be lifted away from the front of the canal.

2. Tumors below the inguinal canal. Of these the most important is *femoral hernia*, which often curls up over Poupart's ligament; the neck of an inguinal hernia, however, if the finger is placed on the spine of the pubes, always lies internal to it; that of a femoral one always external.

3. *Hydrocele*, *hæmatocele* and *tumors of the testicle* are distinguished by the line of separation between the scrotal swelling and the external ring. The only exception is that form of hydrocele which occurs in infants and young adults, in which the tunica vaginalis is closed only at the internal ring, and the swelling extends through the external one into the canal. The swelling, however, begins in the scrotum and the tumor is translucent.

4. Enlargements in the canal are the most difficult, and if there is the least doubt, and symptoms of strangulation are present, an operation should be performed at once. *Fatty tumor* or *sarcoma of the cord*, *encysted hydrocele*, and the *testis descending late*, are the most common, but though their position in the in-

inguinal canal can be altered to some slight extent, none of them can be reduced in the same way as a hernia. It is said that *varicocele* may be mistaken for hernia, although the difference in the consistence and feeling, and the way in which a varicocele disappears when the patient lies down and reappears when he stands up, no matter what pressure is made upon the ring, must make such a thing almost impossible.

Direct hernia is distinguished from indirect or oblique by its globular shape and the absence of fullness along the canal. In old oblique hernia the internal ring may be dragged so far to the inner side that the rupture appears to come straight out from the abdomen; but this never happens unless the size is very considerable. It is sometimes possible, when the opening has been stretched by long-continued traction, to feel the deep epigastric artery.

An oblique inguinal hernia is probably congenital if it occurs before puberty (though it is not confined to this period of life), or if it made its appearance suddenly; in the acquired form it takes some time, often months, to stretch the tissues sufficiently. The relation to the testis is not a certain guide; if the intestine is plainly in contact with it, and envelops it, the hernia is probably congenital; but the converse is not true.

The neck of a congenital inguinal hernia is never shortened in the same way as that of an acquired one; and partly from this, partly from the suddenness of its occurrence, it is very much more likely to be strangulated.

**Treatment.**—1. *Taxis.*—The shoulders and the pelvis should be slightly raised to relax the abdominal muscles, the thigh flexed and adducted, and the patient directed to breathe as quietly as possible, and avoid straining. The fingers of one hand grasp the neck of the sac and pull it slightly downward; the other manipulates the hernia. In direct and old acquired ones the pressure is applied from before backward; in those that are recent or congenital it follows the course of the canal.

If the hernia is reduced, it must be kept from descending again, either by means of a pad and a spica bandage (put on while the limb is flexed) as a temporary measure, or a truss, the pad of which lies upon the internal or external ring, according to the variety, and presses either directly backward or backward and upward, according to the shape of the abdomen. It must not touch the pubic spine or rest upon the cord, and the spring must be so adjusted that while it does not press injuriously when the patient is at rest, it is sufficiently strong to retain the hernia even when he strains downward with the hips partially flexed. In the congenital variety, if the hernia is prevented from descending, the neck of the sac usually closes of its own accord, and, with sufficient care, a permanent cure may be looked forward to in most cases under ten years of age. Owing to the fact that the mesentery does not grow in proportion to the body, the tendency for the rupture to descend diminishes rapidly; but if it comes down once all the good is undone. When the hernia is irreducible but not strangulated, either the rupture must be supported and prevented from increasing by means of a bag-truss, or, if the patient's age and constitution allow it, and the hernia is not too large or too extensively adherent, an attempt may be made to return it and effect a radical cure.

When there is an undescended testicle the treatment depends upon the situation and condition of the organ and the age of the patient. As a rule, if the testis does not descend within a few months of birth, it remains quiescent until puberty. Then it may come down, but whether it does, or whether it remains in the inguinal canal, hernia is an exceedingly common complication and strangulation not unfrequent. If the testis can be pushed either back into the abdomen or out through the ring, a truss can usually be worn, and ultimately a cure may result; but if it remains in the inguinal canal it rarely happens, even with water or air pads, that it is able to accommodate itself sufficiently well. Under these circumstances it is usually advisable to perform some radical operation, and either transplant the testicle, or if it is small and shrunken, or extensively adherent, remove it altogether

and stitch up the pillars of the ring. The same treatment should be adopted when a retained testis is met with in an operation for strangulated hernia.

If strangulation is acute, particularly if the hernia is congenital, the patient should be placed under an anæsthetic, and unless taxis succeeds at once an operation be performed. If, on the other hand, the rupture has been down many times before, and the symptoms are not severe, an ice-bag or a hot bath may be tried and a delay of a few hours sanctioned.

2. *Herniotomy.*—An incision two inches in length is made over the long axis of the tumor, opposite the external ring, and the skin, superficial fascia, and superficial external pudic vessels divided (Fig. 387). The margins of the ring are then defined. In some cases the sac is deeply grooved by the fibres of the external oblique, and if these are divided the constriction is relieved without anything further. More frequently there is only a shallow mark, no real constriction, and layer after layer of tissue is divided on a director until the sac is exposed. This is opened with proper precautions, the forefinger passed along the anterior surface of the protrusion as far as the internal ring, and the seat of stricture felt. The finger-nail is slipped beneath it and a curved blunt-pointed hernia knife passed along the finger with the blade laid flat, until it can be guided beneath the constricting band. The edge is then turned upward and a very small incision made parallel to the linea alba, so that, whether the hernia is internal or external, the deep epigastric artery may not be wounded.

The contents of the hernia must then be dealt with, the sac removed, ligatured or sewn into a pad according to circumstances, and the pillars of the ring sutured as in the operation for the radical cure.

### *Radical Cure.*

By the radical cure of hernia is meant an operation that will not only permanently prevent the hernia descending, but will relieve the patient of the inconvenience of a truss.

In certain cases it is admitted that some measure of this kind is either necessary or very desirable. After herniotomy, for example, if the bowel is not gangrenous or the patient exhausted, an attempt should always be made to close the opening. In other instances there are special reasons why a truss is not desirable; there may be, for example, an undescended testis fixed in the inguinal canal; or a large mass of unreduced omentum over which a pad will not fit comfortably; or the hernia may be of such a nature that no truss is able to retain it; or the patient may be too unintelligent or too careless, or he may be placed in such circumstances that were anything to happen to his instrument it could not be renewed. In such as these there is no doubt—the question is, how far an operation is advisable as an alternative to a truss, and whether it can be relied upon to effect a permanent cure without too much risk.

FIG. 387.—Incision in Inguinal Hernia.

If the cases are properly selected it is certainly effectual. In children, for example, in whom, from carelessness or other reasons, a truss has failed to procure the closure of the canal, in young adults with a recent hernia, and in older men of sound constitution and wiry frame, in whom the inguinal canal has not yet been distorted, a cure is practically certain, and the risk is so small that it is a matter

f question whether it is really greater than that attendant on the wearing of a ss. On the other side, the presence of a hernia disqualifies from entering the rvices, renders a man at the most active period of his life unfit for many kinds employment, and exercises a definite restraint in everything he does.

If, however, the patient has already reached middle life, is comfortable with a ss, and has lost the impulsive activity of youth; or if he is old for his years; if the abdominal walls are thickened and fat, or shaped so as to suggest pro- se of the mesentery; or if there is the least suspicion as regards his general alth—the cure might be effectual; but the risk is too great, provided, that is to r, the rupture can be kept up with a truss. When this cannot be done the ques- n rests on entirely different grounds.

(*a*) *Subcutaneous Operations.*—These, which met with very fair success in e hands of those who devised them, have given way almost entirely to the open es.

*Injection.*—The idea of plugging the canal with lymph by means of injec- n has recently been revived, but not with great success. It may be done either rough an incision or subcutaneously with an instrument devised by Keetley r the Warren syringe]. The scrotum is invaginated with the forefinger, the sac shed well up, and the needle of the syringe passed through the skin from above d outside the internal ring down toward the pubes, until it meets the finger in the nal; when its position is assured, the finger is withdrawn and the fluid injected. bsolute alcohol (five minims) has been tried without confining the patient to d, but the injection had to be repeated many times. Glycerine and tannic acid oduce more reaction; the tissues around swell up, the groin becomes full and der, and a good deal of lymph is effused. [Heaton, of Boston, used extract white oak bark.] But, although the method may be safe, it is not certain. It ay be impossible to injure the hernia with the needle pointing toward the pubes, t the injection may be thrown into the spermatic cord, or some of it may escape to the tissues outside the canal, and the sac is not dealt with in any way. Some these objections are overcome by sutures as well, but in this the open method roughout is to be preferred.

(*b*) *The Open Method.*—In this the sac and the external ring are thoroughly posed. As compared with the former, it is more precise and certain in its re- lts, quite as safe so far as the danger to life is concerned, and does not expose e cord to so much risk. It is, of course, the only plan admissible when the rnia is irreducible.

The operation consists of two distinct steps, one dealing with the sac, the her with the canal. The patient must be carefully prepared, and the parts aved and thoroughly cleansed; the incision through the skin lies over the ex- rnal ring, or may, with advantage, be placed a little higher.

*The Sac.*—The first step is to isolate this thoroughly. In congenital hernia, the cord causes any difficulty, the plan suggested by McEwen may be followed. ne sac is opened and two longitudinal incisions are made in it, one on either side the cord, parallel to it, so that this, with the strip that adheres, is left undis- rbed. If the pouch is open right down to the testicle, the lower end must be parated from the rest to form a tunica vaginalis; but it is not necessary to sew is up; the walls collapse and adhere to each other, or to the testis, almost at once.

When the sac is separated it may be either cut off, the neck being tied and ed by sutures at the internal ring, invaginated, twisted, or sewn up into a pad d pushed into the subserous space, so that it no longer lies in the canal at all. f these, the two last are to be preferred; in both the separation of the sac must complete and the peritoneum continuous with it must be detached for at least lf an inch inside the margin of the internal ring.

(*a*) *Torsion* (Ball).—The sac is first examined to make sure that it is empty. ne neck is grasped with a pair of broad catch-forceps, and, while the finger de- ches the tissues around, is twisted until it is felt to be quite tight and that any rther torsion would tear it. A stout catgut ligature is then placed round the

twisted sac as high as possible, tied tightly, and the ends cut off short. The effect of this is to throw the peritoneum around the opening into a number of spiral folds, extending over such a distance that, in two cases, the opposite ring was narrowed sufficiently to prevent the descent of a hernia. Sutures are passed afterwards through the pillars of the ring and the twisted neck, so as to press the latter toward the abdominal cavity, and prevent anything like a funnel-shaped depression on the peritoneal surface. No ill result has ever been recorded after this, but it must not be forgotten that, in some cases, strangulation of the parietal peritoneum (as in subperitoneal fatty herniæ) has given rise to symptoms of the same character, although of less intensity, as strangulated intestine.

(*b*) *Folding* (McEwen).—In this the sac is thoroughly freed, not only at the fundus and neck, but for half an inch further inside the constricting ring; it is then drawn down, examined to see that it is free, and a stout catgut suture fastened to its base. This is threaded on a needle and passed through the serous layers from side to side at very short intervals, working toward the neck, so that when it is drawn upward the sac is thrown into a series of

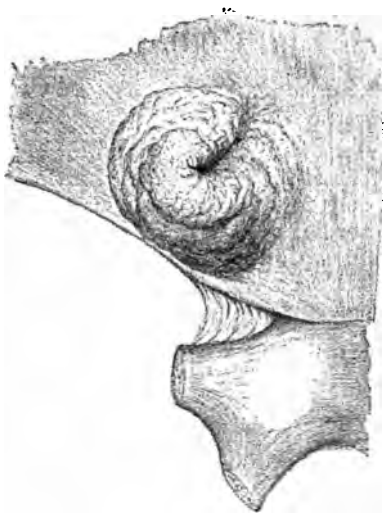

FIG. 388.—McEwen's Pad, as seen from the Inside.

FIG. 389.—The Canal seen from inside, showing its valvular shape. (*After Astley Cooper.*)

short folds closely pressed together. The pad thus formed is pushed inside the ring, and fixed there by passing the suture through the muscles on the front wall of the abdomen from within outward. In this way, a solid block of invaginated sac is placed over the ring—not in the canal—projecting into the peritoneal cavity (Fig. 388), so that when the coils of the intestine are forced downward, they are thrown off on to either side. Owing to the way in which the margins of the ring are refreshed by detaching the peritoneum, the pad very soon becomes adherent at its new site.

*The Canal.*—The second step is to suture this, and restore its valvular shape (Fig. 389).

Where it has not been shortened by the traction of the hernia, the simplest method is to pass a Liston's needle, threaded with silk or well-seasoned catgut, up the canal along the finger until it perforates the inner boundary of the ring. It is then unthreaded, withdrawn (leaving the suture), threaded again with the other end, and passed through the outer boundary at the opposite point. Four to seven sutures, according to the length of the canal, may be passed in this way, each perforating all the structures that form its outer and inner walls, and leaving beneath

them a small space along the floor for the spermatic cord. If the neck of the sac has been tied or twisted, the first suture may be passed through it to hold it well up in the abdomen; but, in any case, it must perforate the boundaries of the inner ring as high as possible. This one should be secured as soon as it is passed; the others should all be inserted before one is tied, in order that the effect on the spermatic cord may be noted when they are all lifted up together.

When the canal is shortened McEwen's plan is preferable; merely stitching the opposite walls together scarcely forms any protection. The finger is introduced into the canal, after the pad formed out of the sac has been placed in position, and the deep epigastric artery and the inner border of the ring carefully defined. A hernia needle with a sharp lateral curve at the end (right or left according to the side) is passed up the canal through the conjoined tendon (in and out) into the canal again, and threaded there, so that when it is withdrawn

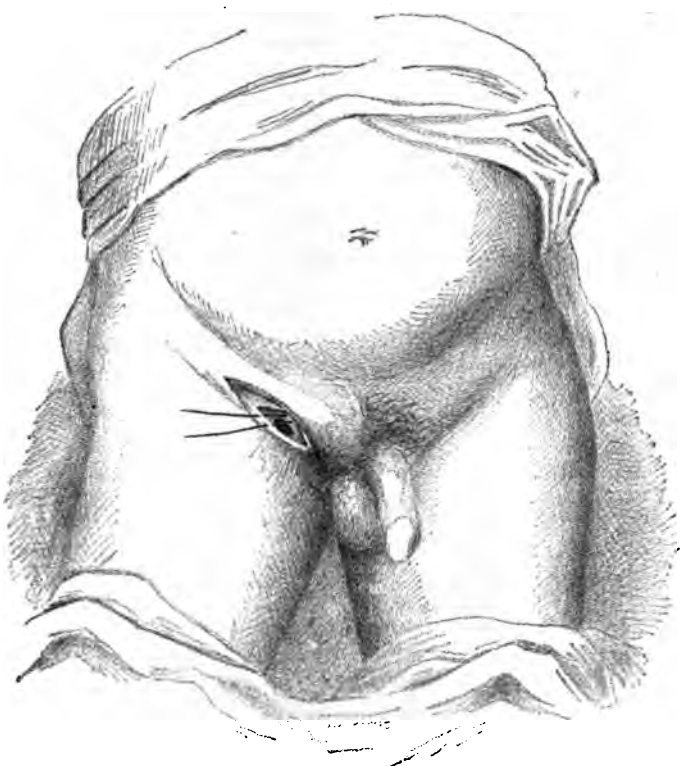

FIG. 390.—McEwen's Sutures to draw the Conjoined Tendon down to Poupart's Ligament.

a loop of catgut is left on the deep surface of the tendon with the two ends fre in the canal (Fig. 390). These are dealt with separately. The upper i threaded on a needle and passed through the internal oblique muscle, and th aponeurosis of the external oblique from within the canal toward the surface, o a level corresponding to the upper end of the loop. The lower is treated in th same way, but is only passed through Poupart's ligament.

By this a double suture is formed across the internal ring, drawing its inn margin outward toward the under surface of Poupart's ligament. The two fr ends emerge on the surface of the external oblique, the loop lies on the abdomin side of the conjoined tendon; when the ends are tied together this is dra directly outward and downward until it lies beneath the margin of the ou pillar and closes the ring like a valve.

anything like a conjoined tendon. In one, at least, there was nothing attached to the ileo-pectineal line, and probably this was the cause of

ıtures should either be of chromicized catgut, tendon or silk: their secure the position of the sac and the walls of the canal until a sufficient ymph has been thrown out to consolidate them and glue them all Wire is unnecessary; it cannot hold fibrous tissues together if there is and although, if the wound heals by the first intention, it becomes disappears, it is always liable, years afterward, like any other foreign lded in soft parts, to set up a certain amount of irritation, and grad- te its way out. In a successful case the tissues become hard and dense eration, and not unfrequently after the stitches have been absorbed, or, 'e lost all hold on the parts, the walls of the canal become more and approximated by the gradual contraction of the lymph that has been

The sutures should never be drawn too tight for fear of their cutting ı, and care should always be taken that a sufficient amount of space is spermatic cord.

FIG. 391.—The Pillars Open, the Cord Held Up.

FIG. 392.—The Pillars Sutured, the Cord



FIG. 393.—The Deep Fascia Closed over the Cord.

particular case, is at present most in favor in the United States. This consists essentially in a reformation of the inguinal canal and transplantation of the cord. Bassini asserted that his method was without danger, that the cure was permanent, and that no truss was required after the operation. Marcy thus describes the operation: "He lays open the canal to the internal ring. The sac is carefully drawn down, ligated, and resected. The closed peritoneum is returned, the spermatic cord pushed aside, and the posterior margin of Poupart's ligament exposed. The deeper layer is dissected in such a manner that it can be brought in apposition to Poupart's ligament. From the ileo-pubic tubercle the canal is closed posteriorly, from five to seven centimetres, to the entrance of the cord into the abdominal cavity. The cord is then replaced, and the aponeurosis of the external oblique sutured, only opening sufficient for the cord without compressing left. The wound is closed with drainage."

In my hands this operation has been modified by freshening the edges of the canal and suturing with stout chromicised catgut, or whale tendon, or kangaroo tendon, the "purse-string" method most frequently used; the cord is then allowed to drop down, as in Bassini's operation, and the wound closed without drainage. In no case has death follow the operation, and I habitually employ it after release of the intestine in strangulated hernia. My youngest patient with strangulation was three months old (Presbyterian Hospital, Chicago, 1892), and my oldest was seventy-four years.]

### FEMORAL HERNIA.

Femoral hernia is the protrusion of the intestine into the crural canal, forming a small conical tumor, the base upward and outward. It is bounded in front by Poupart's ligament, the femoral arch, and the sharp crescentic edge of the fascia lata; on the inner side by the lacunar part of Poupart's ligament; on the outer side by the femoral vein, and behind by the pectineal fascia (Fig. 394). In very rare instances the rupture passes externally to the femoral vein.

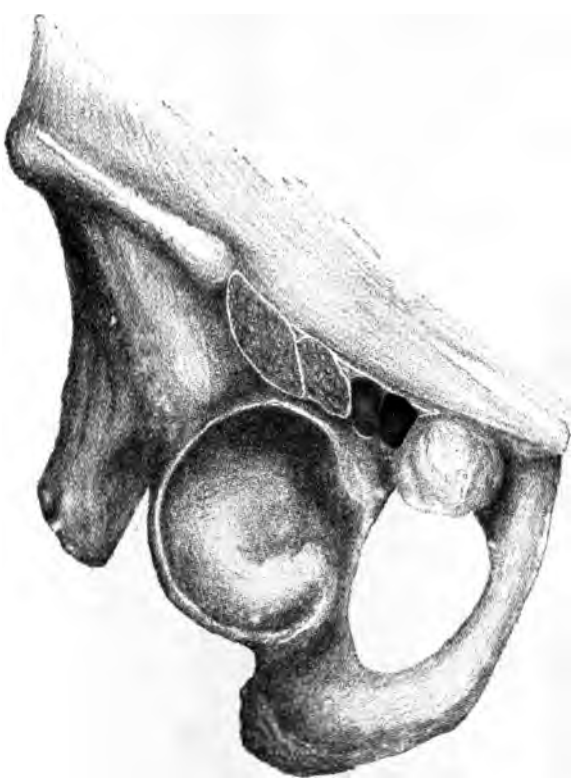

FIG. 394.—Femoral Hernia.

Femoral hernia rarely occurs under puberty, and is more common among women than among men. The hernia is always acquired, the tissues that lie in front of it are pushed down and compressed so as to form a fascia propria. The saphenous opening comes into contact with the cribriform fascia, and as this gives way the hernia curls upward upon itself until it projects over Poupart's ligament, and upon the abdomen. The size is rarely very large, although moderate size is not uncommon. The contents may be intestine only, but in a large proportion of instances there is as well a mass of irreducible and adherent omentum. In one or two cases the cæcum has been found inside

Femoral hernia either forms a small, tense, rounded tumor immediately below Poupart's ligament, or a larger, softer swelling, of irregular shape, traceable to a neck in the crural canal. So long as it is not strangulated there is an impulse on coughing; and if the portion of intestine is not too small (Littre's hernia usually takes place here) or too much covered in with omentum, it may be resonant on percussion.

**Diagnosis.**—*Inguinal Hernia.*—Sometimes, especially in women, a fold which may be mistaken for the fold of the groin extends across the thigh lower down; but the spine of the pubes can always be felt, and the neck of a femoral hernia always lies below it and to the outer side.

*Psoas Abscess.*—The swelling in this case lies beneath the vessels as well as to their inner side; there is a fullness in the iliac fossa above; fluctuation can usually be detected, and gradual reduction takes place when pressure is made upon the swelling.

*Varix of the femoral vein* occasionally resembles femoral hernia; there may be an impulse on coughing; but if the finger is placed on Poupart's ligament after the swelling has been reduced the vein is filled from below.

*Enlarged lymphatic glands* often present great difficulty, especially when there is only one and it is not elongated transversely; but it never possesses a neck like that in hernia.

*Fatty growths* in the canal, *cysts*, *hydrocele of the sac*, and a *thickened empty sac* often cannot be diagnosed. In such circumstances, if symptoms of strangulation are present, an exploratory operation should be performed.

**Treatment.**—1. *Reducible Hernia.*—This should be supported by a truss the pad of which presses a little upward as well as backward, hooking under Poupart's ligament, and is beveled off on the outer side so as not to compress the femoral vein.

2. *Irreducible but not Strangulated.*—If there is only a small amount of omentum (the common form) a pad may be moulded over the protrusion to prevent its increasing; or an attempt may be made to effect reduction by taxis after the prolonged application of ice combined with scanty diet and iodide of potash; but, especially in young women, it is advisable to have the sac opened, the omentum removed, and a radical cure performed. On the one hand there is the exceedingly slight risk of the operation; on the other there is the existence of an omental band passing down from the stomach to the groin, exposing the patient to the danger of internal strangulation, and forming a kind of inclined plane which guides the intestine infallibly to the weakest spot in the wall. In most of the cases in which operation is required a small knuckle of intestine is caught and concealed behind irreducible omentum.

If Gimbernat's ligament is too freely incised, the hernia that follows is either irreducible, or, if it can be reduced, cannot be retained in position. In such cases a firmly-made thigh belt, laced up, with a triangular pad to fit in Scarpa's triangle affords more relief than anything else. It should either be attached to a truss or provided with a pelvic band of its own.

3. *Strangulated.*—In femoral hernia the symptoms are generally acute, and taxis has little chance of succeeding, owing to the unyielding character of the edges of the ring. If a portion of intestine has only just descended, an ice-bag may be tried for a short time in the hope of reducing its bulk; but if it is small and tense and is down for the first time, or if there is an old epiplocele, it is better to give the patient an anæsthetic, and if taxis does not succeed at once, operate. In the one case, if the least pressure is used, the edge of Gimbernat's ligament cuts into the congested bowel; in the other, owing to the mass of omentum in front, the pressure is too diffused to act with any certainty. If the symptoms of strangulation have lasted acutely for more than two days, or if there is a history of many attempts at taxis, especially by the patient himself, the operation should be performed at once.

In applying taxis the position of the patient is the same as for inguinal her

thigh flexed, adducted, and rotated inward. The direction of the pressure is ward and backward, the tumor, if it has spread over Poupart's ligament, being wn downward. The neck of the sac is steadied with one hand, the utmost tleness being used, and softly squeezed from side to side, while the other draws rupture down and then quietly presses it up again.

The incision is vertical immediately over the neck, with its upper end on part's ligament. The layers divided vary in each case, and often it is thought t the sac is exposed when the fascia propria is reached. The difference is plain nce if they are traced up to the neck; the one comes from the abdomen, the er does not. Hey's ligament, the curled-in edge of the falciform process ached to the ilio-pectineal line, is the first tense band divided, and sometimes then hernia can be reduced. More often the deep crural arch and the lower fibres Gimbernat's ligament, where it is separating from Poupart's, must be cut as ll. If there is no reason for opening the sac, the finger nail is slipped beneath m, and the end of a probe-pointed hernia knife gently insinuated and slowly ned round, so as to make a small incision upward and slightly inward. If this l, or if it is not thought advisable to try it, the sac is opened with the usual pre- tions and an incision made from the inside in the same direction.

The incision should be made very slowly by the pressure of the knife, and uld be as short as possible; if more space is required it is better to make a nd than to divide Gimbernat's ligament more freely, as this is usually followed a most intractable form of hernia. Moreover, in a small proportion of cases out one per cent.), the obturator artery pursues an abnormal course, coming off n the deep epigastric and winding round the upper border and inner side of the ral ring. If, as it usually does, it runs down between the hernia and the vessels s not likely to be hurt; but if it loops round it may easily be divided, as it lies ually on the sac. For this reason the finger should be used in preference to a ector, as the pulsation can sometimes be felt. Injury to the vessel may be ided by using a blunt hernia knife; the fibrous tissue is so tense that anything l divide it, while the artery is simply pushed away. If it should be hurt an empt must be made to find the ends and ligature them or secure them with clamp ceps, but without dividing Poupart's ligament; an incision should be made ve it, as for ligature of the external iliac, and a careful dissection carried down til the bleeding points are exposed. In one case the lower end of the artery was wn right into the obturator foramen. Free hemorrhage may occur from the rision of a small vein, but this stops of itself.

The contents of the sac must be dealt with according to the ordinary rules, t especial care is required in femoral hernia, as the constriction may cause ulcer- on, and even sloughing, of the mucous membrane without evidence of much ngestion. Moreover, a small knuckle of intestine is sometimes concealed behind, d even in the interior of a mass of irreducible omentum.

The sac, when it has been emptied, should be detached thoroughly from the ues around, and sewn up into a pad after McEwen's plan. Afterwards a suture y be passed through the boundaries of the ring in a way devised by Wood for radical cure; a Liston needle is passed through the pubic portion of the fascia , entering about an inch below and emerging close to the pectineal line, and n through Poupart's ligament. Catgut, silk, or wire may be used, as in the uinal operation, and two, or at the most three, sutures inserted between Gimber- 's ligament and the femoral vein.

### Umbilical Hernia.

This may be congenital, or it may occur during infancy, or later, during adult .

(*a*) The congenital form of umbilical hernia is due to the visceral plates fail- to meet in the middle line, and allowing some portion of the intestine, and, in

contents, to protrude. Owing
ten found in it.
med from the peritoneum, and exte
ay be so thin that the nature of the
nick. Occasionally it is wanting,
great deformity it is never develo

at its neck should be performed
left the delicate tissues dry up and
strangulation, or where the contents
reducible for other reasons, the sac
the edges of the ring should be bro

is so common in infants is due to the str
It never appears to lead to strangula
the contraction of the orifice, if the rupt
dominal belts with button-shaped projec
rious; the pad should either be flat or p
ry convenient one) or dispensed with altoge
nto two folds, one on either side, and
case of a boy, four years of age, in whom
en the sac (which was very much thickened
ligatured the neck and sewed up the ope
nded lacing the orifice round with a suture.
adult life protrudes through the linea alba
more places than one, so that two hernial
er necks by a tense band of fibrous tissue.
have had large families, and it may attain
e a pendulous tumor filled with omentum, s

reducible, and when it attains any size is especi
and inflamed. Strangulation, when it occ
the tumor is allowed to hang down over
ins are compressed, congestion sets in, the or
len mass, and at length the circulation is stop
ible it must be retained in position by a suit
should be well supported, especially from bein
ted from increasing. Strangulation is often
irreducible for some time and is perhaps obstr
rt or uneasiness: then vomiting begins, and spe
gulation set in definitely. Taxis may succeed,
strangulated loop is shielded by the rest, p
on must be made over the upper part of the t
the neighboring abdominal wall, in the middle
over the margin of the orifice. The sac is e
re generally matted together from constant irritat
s be made to relieve the constriction without ope
not be done, either a small incision must be
n the inside of the sac at one or two points, and
e rest being left as it was before, or the sac ma
s unravele l and released from the omentum, wh
en, and the operation completed as in abdominal
portion. Which of the two should be performed
stances of each case: the latter requires the gre
s tedious and prolonged, but the results do not

In one case in which the walls of the abdomen were enormously thickened from the deposit of fat, I made an incision in the linea alba below the umbilicus, where, owing to the pressure of the tumor, the tissues were not quite so thick as in other parts, dilated the stricture from the inside, and withdrew the strangulated loop. The immediate result was successful, but the patient died some weeks later from bronchitis and prolonged suppuration in the abdominal wall.

### Ventral Hernia.

Hernia through the linea alba (except at the umbilicus) the linea semilunaris, or some other part of the abdominal wall that is not usually weak. It may be the result of defective development, or it may be due to operations, injuries, extreme distention, rupture of muscles, abscesses leaving a yielding cicatrix, or, in short, anything that impairs the strength of the part. It must be treated in all respects like umbilical hernia. Strangulation is rare, although I have met with instances of it. Herniæ of the subperitoneal fat may occur in the middle line, and have been known to cause symptoms of strangulation from dragging upon the peritoneum beneath.

### Obturator Hernia.

Hernia through the obturator canal in the upper and outer part of the thyroid foramen is always acquired, is much more common in women than in men, and rarely occurs until middle age; apparently it is connected with the emaciation and loss of fat which often follow the climacteric. It protrudes either between the obturator externus and pectineus, or through one or other, stretching the fibres over it, and causes an indefinite fullness in the groin, behind and to the inner side of the femoral vessels, between them and the adductor longus. The obturator artery and vein may lie either to the inner or outer side, the relation they bear to the neck of the sac being very inconstant.

This form of hernia is rarely recognized unless it is strangulated. It is always small and deeply buried; and, unless there is pain along the obturator nerve, there is little or nothing to direct attention to it. If strangulation sets in the symptoms are generally acute; the inner side of the thigh is tender and painful; sometimes, if the patient is thin, a certain amount of fullness may be made out, especially when the hips are slightly flexed and abducted; the muscles of the abdominal wall are rigid, and the movements of the thigh are attended with pain. Vomiting and collapse usually come on at once and are very severe. In about half the cases there is a complaint of pain running down the inner side of the thigh to the knee-joint, or even into the leg, evidently due to the pressure upon the nerve; but in many instances this symptom has not been noted. Examination *per vaginam* is stated to have been of assistance in the diagnosis.

Taxis has been successful in a fair number of cases. The thigh should be flexed, adducted, and rotated a little inward to relax the muscles around the hernia as much as possible; and the pressure must be applied from below upward. If this fails to give relief, and the symptoms point to strangulation, an incision should be made to the inner side of the femoral vessels, parallel to them, commencing immediately below Poupart's ligament, and the pectineus muscle exposed. The fascia covering it is divided, the muscular fibres separated and held apart, and the finger passed down to explore the upper and outer part of the obturator canal. If the sac can be made out it must be separated from the tissues around and opened so that the condition of the intestine may be assured. The stricture is divided by cutting either directly downward, or a little downward and outward. In several instances the local symptoms have been so obscure that abdominal section has been performed for the relief of strangulation.

Other varieties of hernia are very rare, and possess but slight surgical interest. *Diaphragmatic hernia* may be either congenital or acquired. In the former

case the protrusion takes place by the side of the ensiform cartilage, between t costal and xiphoid portions of the diaphragm, or through some accidentally w part, and it is usually covered with a sac. In the latter, which is much the m common, any part of the diaphragm may give way and allow the intestines to b forced through the rent into the pleura.

The congenital form scarcely admits of diagnosis: in the acquired one, if th amount of the protrusion is very great (and, occasionally, the stomach, splee part of the liver, and a considerable proportion of the intestine are forced int the pleural cavity), death, generally speaking, occurs at once from the interferen with the thoracic viscera; in other cases, if the patient survives, there is gre distress, arising from the displacement of the organs and the adhesions that fo between them; and strangulation may occur.

*Perineal Hernia.*—In this the protrusion takes place either between t bladder and rectum, or the bladder and vagina, according to the sex. Usually passes through the fibres of the levator ani and forms a soft, easily reducible sw ing to one side of the middle line.

*Pudendal hernia* may occur in women past middle life, the sac descend between the ramus of the ischium and the vagina into the posterior part of t labium. It might be mistaken for a labial cyst.

*Sciatic hernia* has been described by Astley Cooper, the rupture lying betw the pyriformis and the spine of the ischium.

*Lumbar hernia* occurs in Pott's triangle, the small space bounded by the e ternal oblique, the latissimus dorsi, and the crest of the ilium. It must either p through the aponeurosis of the transversalis and the internal oblique, or stret them gradually before it as coverings of the sac.

[See plate opposite, illustrating case of lumbar hernia, back and front vi from photograph sent the editor by Dr. C. H. Mastin.]

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## SECTION IV.—INTESTINAL OBSTRUCTION.

Intestinal obstruction includes all cases of internal hernia, strangulation bands, twisting, intussusception, stricture and impaction. For clinical purpo these are divided into two great classes.

In the one the onset is instantaneous, and the chief symptoms are due to effect upon the nervous system. The patient is in perfect health: suddenly without warning, some part of the bowel is caught or twisted; the circulatio stopped; the great nerve-plexuses are thrown into a state of violent disord vomiting, collapse, and pain come on at once; the vomit rapidly becomes fæc the prostration is complete; and, if the patient does not sink from exhaustion, intestine becomes gangrenous in the course of a few days.

In the other the onset is gradual, and the symptoms for a time ill-defin the health often has been failing; there have been previous slight attacks o similar character, at first relieved easily, then with greater difficulty, until at len absolute obstruction and distention of the abdomen set in. Pain is present, bu comes on spasmodically and grows more and more intense. Vomiting, whe does occur, is due to the accumulation of food, not to the effect upon the nerv system; but the case may run a course of weeks without its happening o Collapse does not come on until the end is approaching.

It must not be imagined, however, that every case can be included at o under one of these headings; the diagnosis of the cause and of the seat of intest obstruction is one of the most difficult in surgery, and often an operation ha be performed with the double object of exploration and relief.

Occasionally the aspect of a case changes suddenly: chronic obstruction

es acute, the symptoms become infinitely more severe, and the patient sinks
prostration, the more rapidly because of the exhaustion caused by the previous
s.

### Acute Intestinal Obstruction, or Internal Strangulation.

The symptoms acute and the strangulation sudden, as in external hernia.

**Causes.**—The most useful classification is that adopted by Treves:—

1. Internal hernia and strangulation by bands of all kinds.
2. Volvulus.
3. Acute intussusception.
4. Sudden obstruction due to gall-stones, or impaction of fæces, with or without previous narrowing of the bowel. Stricture, in most instances, is gradual; but, occasionally, the closure suddenly becomes complete, and the symptoms assume an absolutely acute character.

1. *Internal Hernia and Strangulation by Bands.*—Pouches, which may become hernial sacs, are occasionally developed from depressions on the posterior wall of the abdomen. One of these is the *duodeno-jejunal fossa*, caused by the fold of peritoneum covering the inferior mesenteric vein; another is the *subcæcal*, on the inner side of the cæcum, bounded above by a fold passing from the parietes to the cæcum; and there may be a third, the *intersigmoid*, between the left ureter, the superior hemorrhoidal vein and the spermatic vessels. In other cases a pouch is formed by the yielding of the wall at one spot, the fascia covering the iliacus, for example, so that the peritoneum protrudes into the tissues beneath.

Rings and loops are sometimes present in the peritoneal cavity. A hernia has been known in the foramen of Winslow; but, more frequently, the opening is normal, in the mesentery or the omentum, or in a sheet of lymph thrown out during an attack of inflammation.

Bands and adhesions are more common. Pelvic peritonitis in women and appendicitis in men, are the causes in most of the cases. In some the omentum is fixed in the pelvis, and rolled up into the shape of a fan; this occurs more often in men chiefly owing to the syphilitic, partly owing to the frequency of hernia. In others there is a tough fibrous band thrown across from one part to another of the cavity of the abdomen; or two distant loops of intestine become connected together by an adhesion which, as they move, is stretched out like a piece of string. In a narrow cord; or, in a portion of intestine, the appendix vermiformis for example, or a pedicle of an ovarian tumour, or even a Fallopian tube, is tied down in such a way that a small space is left behind. No matter how it is produced, when a band of any kind is present there is always the danger of strangulation. A piece of intestine slips under it, sometimes in a great loop, and either becomes twisted or else nips itself so that it cannot return; in a very few hours it becomes gangrenous, adhesions are constantly formed, the circulation ceases,

side of the intestine has caused it to bend so acutely as to close the lumen; and the same thing has occurred from the bowel being compressed or held in a bent position, or even from its being tied down by adhesions, especially when it is doubled into a loop.

Bands that are long and loose, or that are attached only at one end, are scarcely less dangerous; in the former case they are sometimes thrown into a kind of spiral coil, through the centre of which a loop of intestine may descend. Probably, as Treves has pointed out, this is of little consequence so long as the intestine is healthy; but if the sides of the loop are adherent to each other, or if the bowel is held by adhesions doubled upon itself, the neck is very likely to be narrower than the rest, and strangulation is highly probable. When one end is unattached, a knot, sometimes of a very complicated character, may be formed around the bowel, and lead to the same result. One end is free and slightly enlarged; this slips inside a loop formed by the rest, the intestine pushing it on until at length the knot is drawn tight and the bowel strangulates itself.

Meckel's diverticulum, the remains of the vitelline duct, is an especial source of danger. Springing from the ileum a short distance above the cæcum, it is directed forward toward the umbilicus. Sometimes it is a tube resembling the small intestine, and opening on the exterior; more often it projects two or three inches, and ends in a fibrous cord; or the end is free and enlarged or club-shaped;

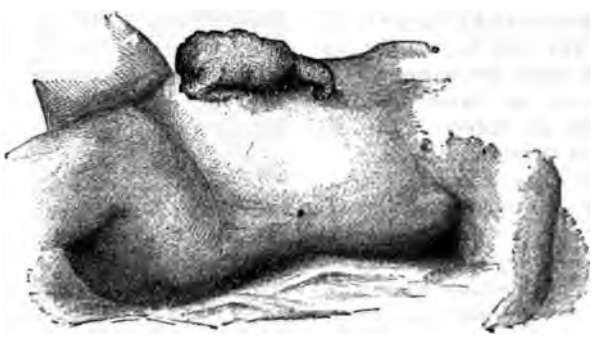

FIG. 396.—Prolapse of Intestine through Meckel's Diverticulum.

or it may have secondary attachments elsewhere. It acts like a peritoneal band: if it is fixed at both ends a loop of intestine may slip beneath and be twisted on itself and strangulated; it may coil itself into a loop, or if the end is enlarged and free it may knot itself into a snare; in a few cases a loop of intestine has fallen over it and become acutely bent; in one or two instances it has exerted such traction upon the intestine as to close the lumen completely; and finally it may allow the intestine to become extruded through it; the mucous membrane is prolapsed first, and this is followed by more and more of the bowel, until there is a huge, intensely congested protrusion, turned inside out, projecting through the umbilicus. In one case of this kind I was obliged to open the abdomen before the mass could be reduced (Fig. 396).

Strangulation by bands or through apertures form, according to Treves, one-fourth of the total number of cases of intestinal obstruction from all causes. Of these more than one-third are due to false ligaments, about one-fifth to the omentum, and rather more than one-fifth to the presence of Meckel's diverticulum.

2. *Volvulus.*—Of this there are two forms. In the more common a loop of intestine, the ends of which lie close together, is twisted around its long axis; in the other, two distinct loops are twisted around each other. A third, very rare form, twisting on its own axis, has been described in the colon.

Owing to its anatomical relations the sigmoid flexure is the common seat of volvulus; but it cannot occur even here unless the mesentery is elongated, and the

ends of the loop dragged close together by long-continued distention. For this reason it rarely occurs under middle life, is almost unknown in children, and is usually preceded by chronic constipation. It may happen to the cæcum, when, owing to the persistence of a fœtal condition, there is a long meso-cæcum and meso-colon; and to the small intestine, if a loop becomes tied together and fixed by adhesions; but these are very rare.

The second form of volvulus may affect the same regions; but it is very uncommon.

The immediate cause is probably some sudden movement of the body; the effect is a tight twisting of both ends, leaving the long and heavy loop hanging down without any power of recovering itself. In some instances the pressure of the anterior abdominal wall seems to retain it. Venous congestion sets in at once; the loop becomes enormously distended with gases that are set free in it; it may even reach the diaphragm, and by its pressure prevent the swelling of other portions of the intestine; peritonitis is almost invariable, and sets in exceedingly early; and ulceration of the mucous membrane in the bowel above the seat of constriction, or gangrene of the loop, follows rapidly. At first the coil can be untwisted without much difficulty, but after a little while the walls become so dense that it rolls back as soon as the pressure is taken from it. Volvulus may prove fatal within forty-eight hours.

Volvulus may occur after the reduction of a strangulated hernia, causing persistence of the symptoms; and in the case of bands strangulation is often the result of the combination, the band and the twist.

3. *Intussusception* is the prolapse of one part of the intestine into the interior of another immediately adjoining. It is a very common form of obstruction, making up very nearly one-third of the whole; and, owing to the mobility of the intestines in children, is especially frequent among them. More than half the cases occur under ten years of age.

If a section is made through an intussusception, three layers of intestine are divided, the innermost or entering layer; the outermost, or sheath; and the middle or returning one, in which the mucous surface is outside, facing the mucous surface of the sheath, and the peritoneal inside, facing that of the entering layer. The two inner layers are known as the intussusceptum. In exceptional cases five and even seven layers are met with.

The mesentery is carried in with the bowel, lying between the peritoneal surfaces of the inner layers, and dragging the intussusception into a cone, the apex of which lies at the point, the base at the neck. A certain amount of elongation is necessary to allow this, but, owing to the direction taken by the bowel, not so much as might be expected: and as an ileo-cæcal intussusception can reach the rectum within a few hours, the increased length is not due merely to stretching. The effect of this traction is, in general, to throw the intestine into a curve, and to tilt up the orifice of the intussusceptum, so that it has the aspect of a slit and looks toward the side of the bowel rather than the axis.

FIG. 397.—Double Intussusception.

Intussusception exists in two different forms. In the common one, the apex of the invagination never changes; the part that entered first continues in front throughout, and the increase is entirely at the expense of the sheathing layer; in the other (ileo-colic), which only occurs at one part of the intestine and is rare there, the ileum slips further and further down the colon through the valve, without the cæcum following it; the increase is entirely at the expense of the small intestine, and the apex is constantly shifting. Not unfrequently after a time this variety changes into the other.

The ordinary form may be enteric, ileo-cæcal or colic. Of these the first and last are seldom met with, and are rarely of any length; the second is the usual one, the ileo-cæcal valve forming the apex, and gradually passing through the colon and rectum until perhaps it protrudes at the anus. The frequency with which intussusception takes place at this spot, is due, to some extent, to the difference in size between the two parts, and to the fixed position of the cæcum, but, as Leichtenstern and others have pointed out, there is a very close analogy between the sphincter-like ileo-cæcal valve and the sphincter of the rectum, and between the invagination that takes place at the one and the prolapse that occurs with equal frequency, especially in children, at the other. Ileo-cæcal tenesmus probably sets in whenever there is any violent catarrh or abnormal irritability of the intestine, just as anal tenesmus occurs in similar conditions of the rectum; and the repeated and forcible peristalsis, driving down on to the firmly closed ileo-cæcal valve, causes intussusception in the one case, just as it causes prolapse of the rectum in the other. If the cæcum is freely movable, as it usually is in children, ileo-cæcal intussusception occurs; if, on the other hand, it is fixed, as in adults, ileo-colic. When once the invagination has commenced, the contact of the swollen and congested apex, stimulating the walls of the intestine below, tends to make it increase indefinitely.

In upward of one-half the recorded cases of intussusception no exciting cause can be found. It is undoubtedly more common in delicate patients than in those who are strong and robust; and in most instances where there is a definite reason for its occurrence, it has followed diarrhœa, free purgation, or colic due to the presence of undigested food. Possibly slight degrees of it, undergoing spontaneous reduction, occur more commonly than is usually imagined in severe colic attended with great prostration. In a few instances it has followed injury, blows upon the abdomen, or jumping a child up and down, and there is no doubt that the presence of fibrous polypi in the intestine predisposes to it. The relation that exists between intussusception and epithelioma is more doubtful. In several cases the apex has been found to be the seat of malignant disease, and in one the convexity of the curve was involved, but it is difficult to say whether this was the cause or the consequence, due to the prolonged irritation.

The method of production, according to Nothnagel, is much the same whether the intussusception is due to paralysis or to spasmodic contraction (which is the more usual of the two), affecting one segment of the bowel. The intestines above scarcely take any share in the proceeding; the longitudinal muscular fibres simply keep drawing the bowel from below, over the narrowed part, until an invagination is produced and the apex has become swollen and congested. True intussusception must be distinguished from the invagination which is not uncommonly found in the bodies of children who have died from cerebral disease. Several of these may occur together, they are never of any size, and can always be reduced without difficulty. Probably they are due to the disorderly character of the peristalsis when the circulation is beginning to fail.

**Effect.**—This chiefly concerns the invaginated part and its mesentery; the sheath may escape altogether, although sometimes it becomes gangrenous, and the part above at first shows scarcely any change; later it may be dilated and the walls hypertrophied, or ulceration may occur and end in perforation. It all depends upon the character of the constriction; where this is very tight the bowel inside becomes intensely congested, blood pours out from the mucous membranes, the walls become thickened and almost solid, especially along the convexity and at the apex, and the intussuscepted part soon becomes gangrenous. The middle layer usually suffers the most severely; in some instances the whole invagination is destroyed and comes away in a mass, the separation taking place at the neck; more frequently it is detached in shreds, and occasionally the inner coat is gradually cut off from the rest, unfolded, and passed with the middle layer, turned inside out.

Where the constriction is less severe a low form of inflammation sets in, the

walls become thickened, adhesions form between the peritoneal surfaces, sometimes at the neck only, but more frequently wherever they are in contact, and if the patient lives the whole of the intussuscepted part may at length slough off. Obstruction is not common, in spite of the thickening of the walls and the way in which the orifice at the apex is dragged to one side by the mesentery. Very often the intussusception is irreducible, even when there are no adhesions—the walls are so thickened, especially along the convexity, and the apex is swollen out to such an extent, that the tissues cannot be unfolded without being torn. The same result may follow from twisting of the bowel inside the sheath, from rigid contraction of the ileo-cæcal valve, or from the presence of a fibrous polypus springing from the mucous membrane.

Where the constriction is very lax there may be little alteration even after months, but not unfrequently after some little time the symptoms suddenly change and become acute. Peritoneal adhesions are more common in chronic than in acute cases, and often render reduction impossible; according to Treves they are present in no less than eighty per cent. Sometimes they are only at the neck, or they may be general, or limited to the part first invaginated, so that the whole can be reduced with the exception of the last few inches. The walls of the bowel above are hypertrophied; sometimes there is considerable distention, owing to the narrowing of the passage by the swelling and bending of the intussuscepted part. Ulceration may occur, but when the bowel becomes gangrenous the process is usually more gradual than in acute cases; it may involve the mucous membrane only, or it may begin at the apex of the invagination and extend slowly upward until in some extreme instances the greater part or even the whole of the large intestine has sloughed, leaving the ileum continuous with the rectum.

4. In *stricture of the intestine* the symptoms sometimes undergo a sudden change, become intensely acute and resemble those of strangulation. This may depend upon a variety of conditions: the narrowed part may have become blocked; a fold of mucous membrane may have fallen over the orifice; the bowel, especially in the case of the small intestine, may have suddenly become bent upon itself, and closed the passage; or, if the obstruction is below the sigmoid flexure, and this becomes greatly distended, volvulus may suddenly set in and cause a fatal termination within a few hours. As a rule, the symptoms are hardly so abrupt or so violent as those of strangulation, and nearly always there is a history of previous trouble and of similar slighter attacks. If the onset is sudden and the symptoms acute, as occasionally happens, especially in stricture of the small intestine, there is no means of diagnosing one from the other.

Gall-stones which have ulcerated through into the duodenum, fæcal accumulations, and very rarely foreign bodies, may cause symptoms of strangulation, even when there is no stricture; but, in this case again, it seldoms happens that they are so acute, or the collapse so extreme. A fatal result, however, has been known to occur from this cause within four days, and the average duration of acute obstruction by impacted gall-stone is only seven.

**Symptoms.**—These conditions are grouped together, because they are sudden in their onset, and because, with certain exceptions, they present the characteristic features of intestinal strangulation, collapse, pain, vomiting, and constipation. Of these the two first are always present, the others are not so constant; vomiting, for example, does not always occur in volvulus, or only makes its appearance toward the end, while diarrhœa, with a discharge of blood and mucus from the anus, is the rule in acute intussusception.

(*a*) *The collapse* is most striking in internal hernia, strangulation by bands, and acute intussusception. The patient is utterly prostrate; the temperature falls; the pulse is feeble and rapid; the face is pinched, the eyes sunken, the extremities cold, and the secretion of urine diminished. The severity depends, to some extent, upon the part involved; it is more marked, for example, in the small than in the large intestine, and nearer the pylorus than at the lower end, but the amount caught and the tightness of the constriction are even more important. In volvulus

the prostration may prove fatal in two or three days, but, as a rule, it comes on more slowly, and reaches its maximum gradually.

(*b*) *Pain* is never altogether absent, although it varies in character and severity. When strangulation is the prominent feature, and the peritoneum and the walls of the bowel are crushed together, it comes on at once and lasts throughout, varied only by attacks of colic, which, as in strangulated hernia, are especially severe when the abdomen is examined. If, on the other hand, the symptoms are due to gradual narrowing of the bowel, as in chronic obstruction, the pain from the first is of a peculiar griping character, coming on at intervals, with periods of repose and comparative comfort between. Later, as the obstruction becomes complete, the attacks grow more and more frequent, and the intervals shorter, until at length it is continuous, with, every few minutes, violent storms of colic, often visible on the abdomen as the coils of intestine move over and over. Tenderness is seldom present, unless peritonitis has set in, or there has been severe cramp affecting the abdominal muscles.

(*c*) *Vomiting.*—As in external hernia, this is reflex, caused by injury to the intestinal nerves. In acute strangulation it begins at once, and persists without ceasing; first the contents of the stomach, then those of the duodenum, and, after a time, of the lower part of the intestine. Toward the end it becomes fæcal, if the obstruction is low down in the ileum, or, if the contents of the bowel are retained sufficiently long for decomposition to set in. In volvulus, on the other hand, vomiting may not be present at all, or it may be very scanty, and even give a certain amount of relief.

(*d*) *Constipation*, in most cases, is absolute. Even when the sigmoid flexure is full of fæces, there is usually no evacuation, owing to the profound effect upon the nervous system. Acute intussusception, however, must be excepted; in this absolute constipation is very rare; diarrhœa is the rule, and nearly always there is a discharge of blood and mucus, with violent tenesmus.

These symptoms are common, more or less, to all forms of acute intestinal obstruction; others are less general, and serve to distinguish one variety from the other.

*Internal strangulation*, however produced, presents the closest resemblance to strangulated hernia. It usually occurs in young adults; the onset is sudden, the collapse, pain, and vomiting (which soon become fæcal) are characteristic; constipation is absolute from the first; there is no tenesmus or tenderness on pressure until peritonitis sets in); meteorism is absent; the coils of intestine cannot be seen through the wall, and no tumor can be felt. As bands are the most common cause, there is a history of previous peritonitis or perityphlitis, or of the reduction of a strangulated (external) hernia, in a very large proportion of cases.

*Volvulus*, as compared with this, very rarely occurs before forty, is far more common in the sigmoid flexure than elsewhere, and is usually preceded by chronic constipation. The onset is sudden, and the pain severe; but vomiting does not commence at once, and, unlike that of strangulation, it may give a certain amount of relief. Tenesmus is occasionally present. The immense distention of the affected bowel, the extreme prostration, and the rapid occurrence of peritonitis are the most important features. The abdomen becomes distended, until the diaphragm can scarcely act; the muscles are tense and rigid, and the walls exquisitely tender; sometimes there is dullness on percussion at the back, but, as a rule, it is resonant all over; no coils of intestine can be seen, and no sign of any tumor. It is possible that manual examination of the rectum and enemata may be of some use in the diagnosis of the ordinary form.

*Acute intussusception* stands in great contrast to these; more than half the cases occur under ten years of age, and a very large proportion in infants. Like the others, the onset is sudden, attended with pain, usually distinctly paroxysmal, and great prostration; but the vomiting is not so constant, and does not occur so early as in internal strangulation, and absolute constipation is hardly ever p
Diarrhœa is the rule, and in more than eighty per cent. there is a di

blood and mucus from the anus, with well-marked tenesmus. A sausage-shaped tumor can be felt in a large proportion, sometimes through the rectum (in which case it bears a close resemblance to the os uteri), more often through the abdominal wall, in the line of the colon; it varies much in distinctness and becomes especially plain during an attack of colic. The region of the swelling is nearly always tender from the first; no coils of intestine are visible, and meteorism and abdominal distention are not marked, until the peritonitis has spread from the region of the intussusception and becomes general. Intussusception in infants, if the parts are very tightly constricted, may prove fatal from collapse in forty-eight hours.

**Diagnosis.**—Acute intestinal strangulation must be distinguished from perityphlitis and peritonitis (especially that form which is due to ulceration of the appendix), and from certain other conditions which, owing to the effect they produce upon the great nerve plexuses, give rise to symptoms of a closely similar character (pseudo-strangulation.)

Sudden obstruction, due to impacted gall-stones or the closure of a stricture, can only be distinguished from internal strangulation by the previous history.

*Perityphlitis* seldom begins without some previous indication; there may have been irregularity of the bowels, or an attack of indigestion; local tenderness in the iliac fossa is an early symptom; sometimes there is a distinct feeling of resistance in the same place, or even a certain amount of swelling; very often there is a history of previous attacks of a similar nature, and usually there is a slight but distinct rise of temperature from the first. *Peritonitis*, again, of such a nature as to be mistaken for acute intestinal strangulation, is always severe, and attended from the first with fever, distention of the abdomen, and intense continued pain. Ascites very soon makes its appearance, the vomiting is of a different character, the skin over the whole surface is exceedingly tender, and, if it is due to perforation, gas very soon collects in the abdominal cavity, and causes a diminution in the hepatic dullness. If, however, the patient is not seen until the peritonitis is already general, or if, as frequently happens in such cases, the patient is too exhausted to give any account of his symptoms, the diagnosis of the cause is impossible.

In *pseudo-strangulation*, on the other hand, or where a part of the bowel is paralyzed, and the symptoms are due, not to inflammation, but to the effect upon the nervous system, the diagnosis is often very difficult, and cases are not unknown in which all the characteristic signs of internal strangulation have been present, and have terminated fatally, without any evidence of mechanical obstruction being found after death.

Paralysis of one segment of intestine may be the direct result of injury, or may be reflex. Instances of the former (*ileus paralyticus*) are not uncommon after the reduction of strangulated hernia, and probably the cases in which fæcal vomiting and other signs of acute strangulation have occurred in the course of typhoid and other diseases that involve the coats of the bowel, or even after injury to the abdomen, are to be explained in the same way; the bowel is so much injured in one spot that it practically acts as a stricture which has suddenly become impassable.

In other cases the paralysis is reflex, excited by some distant affection, inflammation of a retained testicle or of a hydrocele, or phlegmon of the anterior wall of the abdomen, and the symptoms subside as soon as the pain and irritation are relieved. In neither case does the paralysis of the intestine, however produced, account for more than vomiting and constipation; the violence of the pain, the severity of the vomiting and the collapse, are the result of reflex disturbance, starting from the damaged nerves in the bowel, involving the great abdominal plexuses.

Symptoms of a similar character occasionally arise from disease of the nervous system, hysteria, for example, although chronic obstruction is more common. Tubercular peritonitis, meningitis, hepatic and renal colic, dysentery and various [illegible] have at times caused a certain amount of difficulty in diagnosis.

**Treatment.**—In acute intestinal obstruction the first object is to release the bowel, whether it is strangulated by a band twisted on itself, invaginated into another segment, or blocked in such a way as to cause the same symptoms. Except possibly in this last mentioned case, it is of little avail merely to secure the discharge of the contents by opening the intestines above (in volvulus it is done with the hope of uncoiling and releasing the twist); the benefit obtained is only transient, the cause is not removed, the nervous symptoms are not relieved, and gangrene with fatal peritonitis is practically inevitable. It is true that a few cases of wonderful recovery without active treatment are recorded; but the number is exceedingly small, and if the patient is left the chances of spontaneous reduction or of recovery with an artificial anus are infinitely less than in external strangulated hernia.

The more sudden the onset and the more marked the nervous symptoms, the more urgent is the need for active treatment. When the commencement is gradual, preceded, perhaps with other symptoms, the difficulty is greater; but the possibility of an acute termination to a chronic affection must always be borne in mind, and if no diagnosis can be made, and the patient's condition admit of it, an operation should be performed for exploration before it is too late.

1. Where all the characteristic signs of acute intestinal strangulation are present, with sudden onset and symptoms urgent from the first, as in strangulated external hernia. Such a condition may arise from internal hernia, strangulation by bands, omentum, or Meckel's diverticulum, sudden obstruction from kinking, looping, traction, or twisting (volvulus) of the small intestine, from ileus paralyticus or other affections attendant on taxis; or exceptionally from stricture, impaction of foreign bodies or compression by some external tumor. There is no method at present by which it is possible to distinguish one of these from the others; the symptoms are practically the same; and if unrelieved they all end in the same way—gangrene and peritonitis, which prove fatal, as a rule, in the course of five or six days.

The patient should be kept absolutely at rest and as warm as possible; exposure to cold, especially during the operation, is exceptionally serious, owing to the collapse; no food may be allowed, only a fragment of ice to allay thirst, but an enema of brandy may be given with advantage, and if the patient has had no opium a small injection of morphia hypodermically. The effect of this is wonderful; the pain is relieved, the severity of the vomiting diminishes, the skin becomes warmer, the collapse passes off to a certain extent, and the secretion of urine begins to increase. Care, however, must be taken not to mistake the nature of the improvement; the opium relieves the collapse so that the patient appears to rally; it does not remove the cause. This, as in external hernia, can only be done by operation; enemata, massage, and the other methods of treatment that have been advocated from time to time, are worse than useless; they cause delay and inflict further injury.

If the diagnosis is definite, the sooner the operation is performed the better; if it is postponed until the condition of the patient is hopeless it is not to be blamed for the result.

If the vomiting is severe or the stomach much distended, an œsophageal tube should be passed and the cavity washed out with hot water. An anæsthetic is only really necessary for the preliminary incision, and the patient should never be anæsthetized to complete insensibility.

The incision should always be made in the middle line below the umbilicus, a catheter having first been passed to make sure that the bladder is empty. The whole of the abdomen may be explored from this point, there is very little bleeding, no important structures are divided, any part of the small intestine may be brought out through it (except the fixed part of the duodenum), a portion of the colon even has been excised (Treves), and it is practically impossible in the vast majority of cases to localize the seat of the strangulation.

An incision two inches in length is sufficient; the superficial structures are

divided, the peritoneum and the wound extended sufficiently with scissors or with a scalpel, using the fingers as a director; and the gap is filled at once with a loop of bowel more or less congested.

In the easiest cases, where, for example, the strangulation is dependent upon an umbilical band or Meckel's diverticulum, the diagnosis can be made at once with the finger. More frequently nothing can be felt. In this difficulty the coils of small intestine lying near should be carefully inspected and the one that is most congested allowed to protrude into the wound, hot sponges renewed as soon as they become cool, being used to protect and control it. It is true that exposure of the intestine is, as a rule, to be most carefully avoided; if the bowel is allowed to become cool, or even if it is exposed to the air for any length of time, the gravity of the operation is immensely increased, but it is a choice between evils, and probably the protrusion is the least.

It need not be a great coil; nearly always by gently moving it about it can be seen which of the ends is the more congested and dilated, and this guides infallibly to the seat of strangulation. Usually it is not far off, for as Greig Smith has pointed out, the greater amount of bowel is within three inches of the umbilicus, and the most dilated coils rise to the surface. Sometimes, as was first pointed out by Rand, of Liverpool, it is possible to make out which is the upper end of the loop, and even whether it belongs to the nearer or more distant part of the small intestine, by passing the finger down to the root of the mesentery against the spinal column.

If the distention is too great to allow exploration, either the intestine must be punctured with a capillary trocar in many places, to let out the air, or an incision made in the protruding loop in order to empty the neighboring segments. Of these methods the former is scarcely safe; leakage is very likely to occur from paralysis of the walls of the intestine. It has been done through the wound, and guided by the hand, through the abdominal wall at some distant spot; but to afford effectual relief it must be practiced at many points. The other method is strongly advocated by Greig Smith, not only to allow of exploration, but as a means of relief; he points out that in such cases as these the mere distention of the intestine is sufficient to perpetuate the obstruction; the bowel no longer lies in gentle curves, but forms acute flexures which act as valves and prevent its being emptied even after death, and he compares this with the benefit which often follows the use of Kussmaul's œsophageal tube. In short, he regards evacuation of the intestinal contents as an essential part of the operation. The loop of the bowel is secured to some strapping fixed on the front wall of the abdomen by means of four quill sutures passing through the serous and muscular coats, and an aspirator trocar and cannula introduced into the centre of the square marked out. Evacuation may take an hour or more, the abdomen being gently kneaded the whole time, but as soon as the skin incision is made and the sutures passed the anæsthetic should be discontinued.

As a last resource, when nothing can be found, even after the distention is relieved, the opening may be enlarged (if the patient's condition will admit of further exploration), the hand introduced, and the hernial openings, the cæcum, and then, according to its condition, the colon or the small intestine carefully traced back, beginning with a part that is empty and collapsed, until the seat of strangulation is found.

The actual constriction rarely presents any difficulty; small bands can usually be broken down with the finger; longer ones may require division, and in such cases it is as well to ligature them near their attachments and remove them; omentum may be treated in the same way. Meckel's diverticulum, if it has to be divided, should be treated like a portion of intestine, the end invaginated, and the serous and muscular coats sewn together over it. When stricture, or the impaction of a gall-stone or other foreign body, is sufficiently acute to cause symptoms of strangulation, the bowel may be opened and the obstruction removed, or the stricture resected, as the case may be. In one or two instances an impacted gall-

stone has been gently passed on through the ileo-cæcal valve, and Tait has suggested that, as they are very brittle, it might be possible to crush them or split them with a needle. It seldom happens, however, that the condition of the walls is sufficiently good to allow this to be done. In many cases it is wiser to be content with the formation of an artificial anus, which may be dealt with later, when the patient has recovered. The same thing should be done when the state of the bowel is such that its recovery is a matter of question.

Treves has pointed out that, even when one constricting band has been divided and a definite strangulation relieved, it is always as well to make sure that there is no second. Instances of twofold strangulation by bands have occurred on more than one occasion.

The subsequent steps in the operation present no special feature. If the constriction has been found, and there has been no hemorrhage or escape into the peritoneal cavity, the less the parts are disturbed the better; the wound must be closed as in other operations. If, on the other hand, there has been much bleeding, the cavity may require to be sponged out, and if any of the intestinal contents have escaped, it must be thoroughly irrigated with hot water. Drainage must be provided for if peritonitis is present at the time or is expected to follow.

In many cases the condition of the patient is much too critical to stand any prolonged or systematic exploration; the face is drawn and pinched; the pulse very rapid and scarcely perceptible; there is dullness in the flanks, the coils of intestine being filled with fluid; the stomach is distended with fluid and gas without the patient having strength to vomit it up; and there is complete apathy and almost insensibility to pain. In such as these Greig Smith recommends an injection of cocaine, a small incision, and if the seat of strangulation is not apparent at once, suturing the intestine as already described, so that it may be emptied of its contents. It may give relief for a time until the patient rallies, and it is not possible to do more.

The after treatment must be conducted on the same principles as in external herniotomy. The blankets must be warmed, and hot bottles kept round the patient; the temperature, which is not unfrequently subnormal before the operation, is often still further reduced by shock and exposure, and by the anæsthetic; moreover, life has to be sustained on a mininum of food. Nothing may be given by the mouth for at least forty-eight hours; only small fragments of ice at long intervals to allay the thirst; and even at the end of that time food should only be given by the spoonful. The strength must be maintained by small enemata of peptonized food with brandy every three or four hours, so as to allow the intestine ample time for recovery, and the patient must be kept under opium. Hypodermic injections of morphia are the most useful, as there is never any question how much has been lost if the patient should be sick; but the tincture, with an equal quantity of water, is sometimes preferred; and this must be continued until there is no longer any fear of the intestine giving way, or of peritonitis.

The prognosis depends, as in strangulated hernia, upon the condition of the bowel; but there is not as yet a sufficient series of cases to form any estimate as to the probable mortality. It is manifestly unfair to include those (and they form by far the majority) in which the operation has been done as a last resource, when everything else has been tried, when the patient is in a state of collapse, and general peritonitis has set in; sometimes even under these circumstances it has proved successful, and there is no reason why, if it were done before the bowel is too much injured and the patient's strength exhausted, the mortality should be much higher than after external herniotomy.

2. *Volvulus*, when it affects the small intestine or the cæcum, cannot be diagnosed from the preceding; if such a condition is found after laparotomy, an attempt must be made to uncoil the bowel, or, failing this, the loop must be emptied through an incision and an artificial anus formed.

Volvulus of the sigmoid flexure has never been known to recover without operation, though in one case (quoted by Treves), which terminated fatally at last,

sometimes of assistance when the walls of the abdomen are thin and flaccid, as in a child, and when the swelling can be distinctly felt. By itself it is probably of little value. How much fluid should be used varies necessarily with every case, and no guide can be laid down.

When reduction is successful the tumor can be felt to slip away suddenly from under the hand, sometimes, but not often, with a gurgling noise; the abdomen becomes evenly and slowly distended, and the severity of the symptoms disappears at once; but of these signs the last is the only one upon which any reliance can be placed. The intussusception may apparently be reduced, but in reality be only concealed by the distention of the rest; or the apex may remain caught, owing to the way in which it is swollen; or the bowel itself may give way, and the contents suddenly discharge themselves into the peritoneal cavity.

If enemata fail, or if the intussusception persistently returns, the choice lies between leaving the bowel to itself while the patient is kept under the influence of opium, or performing laparotomy at once.

The duration of these cases varies very much: acute ones, especially in young infants and in the small intestine, may prove fatal within forty-eight hours; the majority last from four to seven days; some survive for longer periods still. The chances of spontaneous recovery, however, are exceedingly slight; in infants, according to Treves, elimination occurs in only 2 per cent.; and, between the ages of two and five, in no more than six; and even when this does take place the result is fatal in the majority. Between eleven and twenty years of age, on the other hand, the results of the expectant method are more successful; the deaths after spontaneous separation are only twenty-eight per cent.; but after that time, again, the chance of recovery becomes more remote. Clearly, therefore, so far as infants are concerned, spontaneous recovery is very doubtful; and though the prospect may be better in youth and young adult life, it must be remembered that elimination, to commence with, does not occur in more than half.

There are no statistics showing the results of early laparotomy; in acute intussusception, if enemata fail, it should be done at once, within twenty-four hours, in the same way that herniotomy is done at once if taxis fails; it is of no use waiting until collapse or peritonitis has set in, or the patient's strength is exhausted; and the chances of an acute case becoming chronic, or, if it does become chronic, of the patient's surviving, are much too remote to deserve the least reliance.

The operation must be performed in the same way and with the same precautions as laparotomy for intestinal strangulation, the incision being in the middle line. When the intussusception is exposed an attempt must be made to draw down the sheathing layer from off it, using the utmost gentleness for fear of tearing the bowel, which is often much softened already; it is of no use, in most instances, trying to draw the intussusception out. Sometimes this succeeds at once; but, even after three days, it may be impossible, either from adhesions, from swelling and congestion of the invaginated part, from the way in which it is twisted and curved inside the other, or from the presence of a polypus. In such a case, or if the bowel is torn or gangrenous, the only choice left is primary resection, suturing the ends together; short-circuiting the intestine by means of Senn's approximation plates; or forming an artificial anus, leaving the intussuscepted part to take care of itself. The first, no doubt, is the ideal one, but in most cases that proceeding is advisable which can be accomplished most quickly and with the least disturbance.

### Chronic Intestinal Obstruction.

The onset gradual and the symptoms due not so much to the reflex action of the nervous system as to the progressive narrowing of one portion of the bowel.

In many instances the final attack has been preceded by slighter ones. At first they attract but little attention: the narrowed part is blocked by some undigested food or fæcal mass which soon gives way; constipation and colic last for a time, and then there is a certain amount of diarrhœa. Later, as the constriction

grows tighter, these attacks become more frequent and last longer; and, at length, in one of them the closure is final, and the obstruction complete.

The pain is intermittent at the first, with long pauses between. As the passage becomes narrower the paroxysms grow more severe and the intervals shorter, until at last there is a continuous griping all over the abdomen, with every now and then violent storms of colic. There is no collapse until near the end. It is due to peritonitis or exhaustion, not to the injury inflicted upon the bowel. Vomiting, in the same way, is caused by the accumulation of food, or the action of purgatives, and may not appear for weeks; the time when it does occur depends chiefly upon the distance of the obstruction from the pylorus. Constipation is absolute, although the rectum may be emptied. Meteorism is very marked, especially if the obstruction is low down; the walls of the abdomen gradually become thin and stretch before the increasing pressure, and the coils of intestine, enlarged and hypertrophied from the increased amount of work, are visible in many cases, on the surface of the abdomen, especially during the attacks of colic.

In spite of this difference it is impossible, in many cases, to draw a definite line between obstruction and strangulation. Sometimes, as in impacted gall-stones, the first closure is final and the symptoms intensely acute; or in true intestinal strangulation, slight attacks of a similar character have occurred previously and been mistaken for colic; or, again, intestinal strangulation suddenly happens to a patient who is already suffering from chronic constipation. The distinction that is wanted is a clinical one; the pathological data are fairly clear, but as yet it does not seem possible to place them in definite association with the symptoms.

**Causes.**—(1) Narrowing of the lumen of the bowel, whether due to stricture, compression from the outside, or to looping, bending or twisting of the bowel itself. (2) Loss of muscular power and accumulation of fæces. (3) Chronic intussusception.

1. Of these by far the most common is *stricture*, originating in the mucous or submucous layers of the bowel, and caused usually by cicatricial tissue or by carcinoma.

*Simple stricture* is occasionally met with in the small intestine, and then it may be multiple; in the large, in which it is nearly always single, it is infinitely more common. Upward of one-half occur in the region of the sigmoid flexure; from this they gradually become more rare as the cæcum is reached, although stricture of the hepatic flexure is slightly more common than that of the transverse colon. In the small intestine it is most frequent toward the lower end; occasionally it involves the ileo-cæcal valve.

In most cases the cause of the ulceration has disappeared; there is nothing either in the shape or character of the cicatrix to lead to any conclusion. Of the rest a large proportion is due either to dysentery or tubercle. The former leaves behind it exceedingly irregular cicatrices, very often involving a large extent of bowel, and so hard and dense, and associated with so much contraction that, according to Treves, not improbably some of the cases of reputed scirrhus are really due to this. The latter is more common in the ileum, where it may either spread in a longitudinal direction producing little effect, or around the bowel transversely, in which case, if it cicatrizes, it leaves an annular stricture, rarely very tight. Ulceration following catarrh, or due to the irritation of long-retained fæces (stercoral), is not uncommon in the large intestine, especially in the cæcum. Syphilis, in all probability, accounts for a few; and stricture is said to have been caused by the peptic ulcers that are occasionally found in the first part of the duodenum, and even by those that occur in typhoid fever.

Stricture of the small intestine sometimes follows blows and severe contusions of the wall of the abdomen, and may occur after the reduction of strangulated hernia, owing to the injury sustained by the mucous membrane.

*Malignant stricture* may be either primary or secondary; the former is probably always due to columnar epithelioma; the latter naturally depends upon the character of the original growth.

Columnar epithelioma generally occurs as an annular constriction, the growth following the course of the vessels; much more rarely in the form of nodules or flattened plaques. The stricture is always short and narrow; from the outside it seems almost as if a piece of string had been tied around the gut. The peritoneum is usually thickened and sometimes is adherent; the rest of the structures disappear; there is merely an irregular ulcer extending transversely around the interior of the bowel, with its base and sides hardened and infiltrated by the new deposit. Very often the diameter is so small that it scarcely admits a goose-quill.

*Non-malignant tumors* of the bowels, adenomata, fibromata, and fibro-myomata, have a tendency to assume a polypoid shape, and may lead to intussusception, but they rarely of themselves obstruct the interior. Lympho-sarcoma sometimes causes immense thickening of the wall, but seldom gives rise to any symptoms.

*Compression.*—The rectum, the sigmoid flexure, and the lower part of the ileum (especially those coils which hang down into the cavity of the pelvis) may be compressed by tumors growing from the walls of the abdomen or connected

FIG. 398.—Malignant Disease of Large Intestine.

FIG. 399.—Annular Stricture due to Epithelioma.

with the other viscera. In some cases the symptoms are acute; in twelve out of twenty-two collected by Treves the patient died before the ninth day (in one on the second); the bowel was suddenly caught in some way, or bent upon itself, and though the pain and collapse were scarcely so marked or so severe as in strangulation by bands, the points of difference were not sufficient to make the diagnosis certain. In the others the course was chronic, sometimes resembling that of stricture with intermittent colic, sometimes presenting nothing but increasing constipation.

In most cases this compression is affected by a tumor growing from the pelvis, or connected with the pelvic organs, the retroverted uterus, for example, and uterine or ovarian tumors; but it has been caused by vesical calculus, abscesses connected with the bones or the viscera, extra-uterine fœtation, tumors of the kidney or pancreas, floating kidney, hydatid cysts, and even by an enlarged and displaced spleen.

Compression may also be caused by peritoneal adhesions, especially at the hepatic and splenic flexures of the colon. In some cases the peritonitis may be

due to fæcal accumulation; in others it spreads from the liver, gall-bladder, or other neighboring structures; in others, again, it follows ulceration of the mucous membrane, and the cicatricial stricture inside the bowel is made worse by the peritoneal thickening around it. Whatever may be the cause, the bowel becomes narrowed; the walls become hard and dense, and a stricture is formed which cannot be distinguished by any of its symptoms from that which is due to dysentery or malignant disease.

Matting together of the intestine after operations for strangulated hernia, or ovarian tumors, pelvic or tubercular peritonitis, bending of the bowel, forming a valve in the interior, or limited adhesions impeding the peristaltic action of one segment, may all, according to Treves, give rise to the symptoms of chronic obstruction. Volvulus is nearly always acute; in one or two of the cases, however, in which the cæcum has been concerned, it has lasted some length of time, and the symptoms have resembled those of obstruction rather than strangulation.

*Obstruction by gall-stones and foreign bodies* resembles compression of the bowel in this, that while many of the cases are exceedingly acute others are chronic, the masses lying latent for years, and then, perhaps, causing symptoms of slow obstruction. Gall-stones find their way in by gradual ulceration, so that sometimes there is a history of previous peritonitis. Foreign bodies for the most part consist of materials swallowed in small quantities from time to time and worked up into solid masses with mucous or vegetable fibre. Pins, cherry-stones, cocanut-fibre, yarn, and many other substances have been met with on various occasions, rolled up into enormous masses. Concretions, composed of carbonate of magnesia (taken as medicine), phosphate of lime and magnesia, and other indigestible substances mixed together are more rare, but occasionally attain an enormous size.

2. *Loss of Power in the Muscular Fibre of the Intestine and Accumulation of Fæces.*—This rarely happens in the small intestine, but is not uncommon in the large, especially in the cæcum, transverse colon, and sigmoid flexure. The causes are very various—want of exercise, hysteria, chronic catarrh of the mucous membrane, hereditary influence, in short, anything that tends to impair the activity of the peristalsis. As a result the fæces collect and become hard and solid, the bowel below contracts, that above becomes distended; at length, the muscular fibres, already too weak for their work, are stretched until they are not able to contract at all, and the passage is completely obstructed (*ileus paralyticus*). In many of the cases, as mentioned already, chronic peritonitis sets in and increases the difficulty by the thickening of the serous coat that it causes; in others ulceration of the mucous membrane occurs in the bowel above, and even if the obstruction is removed in time to prevent perforation, the subsequent cicatrization may lead to the formation of a true stricture.

3. *Chronic intussusception* is a term applied somewhat arbitrarily to cases that have lasted longer than a month. It is classed with chronic obstruction more as a matter of convenience than because of the symptoms, for these are of the most indefinite and irregular character.

**Pathological Effects.**—The consequences of obstruction are, speaking generally, the same as those that occur elsewhere in the body under similar conditions—dilatation and hypertrophy; but, from anatomical reasons, and because of the nature of the contents, they differ considerably in their importance.

Where the difficulty has arisen slowly, the coils of bowel, especially in the case of the small intestine, sometimes become of immense thickness, so that during the attacks of colic, when they are seen through the abdominal wall, they may be mistaken for the transverse colon. The distention is greatest immediately above the obstruction; the splenic flexure, for example, may be as large as the stomach, and the sigmoid one may stretch right over the other side of the abdomen; the mucous membrane becomes exceedingly thin; stercoral ulcers make their appearance, and sometimes, partly from the compression of the blood-vessels, partly from the irritation of the retained fæces, extensive tracts become gangrenous. In the

case of the large intestine the ulceration is most marked immediately above the obstruction, and in the cæcum, where, if the ileo-cæcal valve is competent, the pressure is greatest, the intermediate portions may be quite intact, or the whole surface may be more or less involved. Perforation is not uncommon, leading to fæcal extravasation and general peritonitis; in some exceptional cases the extra-peritoneal portion of the bowel gives way, or adhesions form between two neighboring coils, so that a fistula is established and this result avoided.

**Causes of Death.**—Death may ensue in various ways in the course of chronic intestinal obstruction. Perforation, for example, may take place suddenly, and lead to fæcal extravasation; the stricture may become blocked by a mass of fæces, or some foreign body, or it may be covered in by a fold of mucous membrane; volvulus or acute bending may occur; or the bowel above may gradually become so dilated that the pressure alone is sufficient to close the opening, and the symptoms suddenly, from one hour to another, become acute, resembling, but rarely quite so severe as, those of strangulation. In other cases, especially where there is malignant disease, the stricture gradually grows so narrow that at last the patient dies, worn out and emaciated by the long-continued trouble. Very narrow strictures may exist for a long time in the small intestines without causing any symptoms, owing to the liquid character of the contents, and occasionally, but much more rarely, when there is persistent diarrhœa, this happens in the large.

**Symptoms.**—1. *In stricture, peritoneal adhesions, and compression*, the symptoms, so far as the obstruction is concerned, are essentially the same; the differential diagnosis is often impossible, except from the history and age of the patient, from the presence of a tumor or some other additional evidence, and the locality is in many cases equally uncertain.

*Colic, constipation,* and *distention* of the abdomen are generally present. In a typical case the attacks at first are intermittent, with intervals of comparative comfort; but as the constriction becomes narrower, they grow more and more frequent until at length, when the obstruction is complete, they never really cease, although they are worse every now and then. Sometimes they occur suddenly in patients who are perfectly well to all appearance; more often they are preceded by dyspepsia, diarrhœa or constipation. In a few rare cases there is only one, the bowel becomes kinked, or the narrowed portion is blocked for the first and last time, and the symptoms are those of strangulation. In most cases the onset is insidious, and the first attacks slight, merely regarded as indigestion; only as the case progresses do they become definitely associated with vomiting and constipation.

*Pain.*—As a rule nothing can be gathered from the locality of the pain; as often as not it is referred at first to the umbilicus, but it soon becomes general, and it rarely happens that the patient is able to describe it as beginning and ending at any definite spot. It is due to violent peristalsis, and is always griping, even when it is continuous; the coils, which are nearly always visible through the wall of the abdomen, working over and over each other. Food, enemata, and even digital examination of the rectum, may bring on an attack. Sometimes toward the end it becomes less severe, probably from the muscular and nervous mechanism of the bowel becoming exhausted.

The pain is generally more acute when the seat of obstruction is in the small intestine; in this case it is often traceable to the food, coming on at regular intervals after meals, and it may be relieved by aperients, which when the colon is concerned merely aggravate it.

*Constipation* is the rule. During the attacks of colic it is always present, and as they pass off is often followed by diarrhœa. In the small intestine, where the contents are liquid, it may not appear until comparatively late; and until the constriction is very tight, it may generally be relieved by aperients. When the colon or the sigmoid flexure, on the other hand, is involved, there may be a certain amount of spurious diarrhœa for a time, similar to that which is often present in fæcal accumulation, kept up by the irritation of the mucous membrane; but always

at length the obstruction becomes complete, and sometimes no motion is passed for weeks before death. A single copious motion after prolonged obstruction is, according to Treves, often significant of perforation.

*Meteorism.*—The distention of the abdomen depends upon the seat of obstruction and the amount of diarrhœa; when the constriction is high up it may be altogether wanting, except, perhaps, during the attacks of colic, and in some cases there is retraction instead, owing to the emaciation. On the other hand, in stricture of the sigmoid flexure, the enlargement may be immense, the diaphragm being pushed up into the thorax, displacing the heart, and seriously impeding respiration. During the attacks of colic, and if peritonitis sets in, the walls become tense and tender; at other times they are soft, so that when the coils of bowel are distended with fæces and flatus they may be felt as well as seen through them.

*Vomiting*, unless the obstruction suddenly becomes acute, is not a prominent symptom. Its occurrence and severity depend upon the seat of obstruction and the amount of food; when the stricture is near the pylorus it rarely fails to make its appearance early in the attacks of colic, and may be very profuse; when it is in the large intestine and the food is carefully selected, it may not occur for weeks, and it rarely becomes fæcal until complete obstruction has lasted for some time. Other symptoms, which may be of help in diagnosis, are occasionally present. Tenesmus only occurs in stricture of the large intestine, and is rare even then. In carcinoma of the sigmoid flexure there is not unfrequently a thin blood-stained discharge from the anus, especially in the intervals between the attacks of obstruction. Sometimes a tumor can be felt, either *per rectum* or through the abdominal wall, but rarely when the small intestine is concerned. Masses of fæces can occasionally be felt in the cæcum or the transverse colon, and this may be stretched and displaced so far as to reach the symphysis. The outline of the colon may be seen, or there may be dullness or percussion along some part of its course—in one flank, for example, and not in the other—and in some few cases valuable information may be obtained by means of enemata, or by the introduction of the hand into the rectum.

2. *Obstruction due to fæcal accumulation* rarely occurs until comparatively late in adult life, and is more common in women than in men. Not unfrequently it is associated with hysteria or hypochondriasis, and nearly always there is a history of chronic constipation for years past; the bowels have only acted at long intervals and after aperients or enemata, and the motions have become copious and exceedingly hard. In other cases the patient complains of persistent diarrhœa with thin watery stools; the mucous membrane of the bowel is irritated by hard scybalous masses, and the secretion mixed with the liquid portion of the fæces is constantly flowing down into the rectum.

The symptoms are essentially the same as those of stricture of the large intestine, only they are as a rule more chronic; in rare instances there is a sudden acute attack with prostration and vomiting, probably due to the bowel becoming bent or twisted upon itself in some way, or to atony of the muscular wall. The patient is a martyr to dyspepsia; the tongue is foul; the appetite poor; the breath exceedingly offensive, and there are constant attacks of flatulence with distention and severe griping pain and nausea. The abdomen is large and resistant; fæcal masses may often be felt through its walls, sometimes in the cæcum, lying in the right iliac fossa, more often in the transverse colon or the sigmoid flexure. Tumors of considerable size are occasionally formed in this way, but their nature may almost always be made out from their mobility, variable shape, and doughy consistence. The diaphragm is pushed up, causing palpitation and interfering with respiration; the portal circulation is obstructed so that hemorrhoids result; sometimes the uterine, spermatic, or iliac veins are affected as well; and the patient loses flesh and strength and not unfrequently becomes hypochondriacal. In many instances this condition persists for years, relieved from time to time with aperients and enemata, but there is always the danger that sooner or later the muscular

power of the bowel may fail, or the distention above increase, until at length ulceration and perforation occur.

3. *Chronic intussusception* is exceedingly variable in its course. It is rare in children, and is nearly confined to the large intestine. The onset is usually sudden; in most instances a tumor can be felt through the abdominal wall, or *per rectum*, and the coils of small intestine can often be seen, especially during the attacks of colic. Vomiting may occur, but it is not urgent like that of strangulation; tenesmus and a discharge of blood-stained mucus are rarely absent; sometimes there is constipation, but more frequently a kind of spurious diarrhœa. The pain is seldom severe, except during the attacks of colic, when all the symptoms become intensified. This condition has been known to continue with fluctuations for months; as a rule, after it has lasted some length of time, either the bowel becomes strangulated or the patient becomes exhausted from the prolonged suffering and want of food, grows thinner and thinner, and succumbs at last rather suddenly.

**Diagnosis.**—The diagnosis of intestinal obstruction is always a matter of the greatest difficulty, and in most instances the examination of the abdomen has to be repeated time after time, during the attacks of colic as well as during the intervals, with an anæsthetic as well as without, before a definite opinion can be given.

1. *The Previous History of the Patient.*—In stricture and fæcal obstruction there is generally a record of previous slight attacks of a similar character, yielding at first easily to remedies and gradually becoming more severe; constipation has often continued for a time, and then given way to diarrhœa; and the patient has been distressed, and the action of the bowels and the digestion disordered, for some considerable period. Scybalous masses passed from time to time, and habitual constipation for years before, point rather to the latter, though it must not be forgotten that this may be merely a complication; a blood-stained discharge from the anus is suggestive either of malignant stricture low down or of chronic intussusception.

Antecedent attacks of local peritonitis or typhlitis; strangulation of a hernia some months before; injuries to or operations on the abdomen; hepatic colic, dysentery, gastric ulcer, or any other intestinal trouble; or the history of an abdominal tumor, may be of very great significance. Rapid wasting, without sufficient apparent cause, is suggestive either of tuberculosis or of malignant disease; but a certain degree of emaciation is always present in chronic obstructions, and if the case lasted any time it may be very distinct.

2. *The Mode of Onset of the Present Attack and the Order of Appearance and Severity of each of the Symptoms.*—If it commences suddenly and the vomiting and prostration are serious from the first, it must be regarded as a case of intestinal strangulation. Pathologically the actual cause may be a gall-stone or some other obstructing agent; the symptoms are those of strangulation and must be met in the same way before it is too late.

If it is gradual, each symptom must be taken in order. First the pain, whether it is griping, as in colic, and whether the paroxysms are becoming more frequent, showing that the obstruction is growing tighter. If it occurs a short time after taking food and is relieved by aperients it is probably due to stricture of the small intestine; if it is continuous, the obstruction is complete; if it is made worse by digital examination of the rectum or by enemata, it is most likely in the large intestine; and if it is distinctly localized, or if it always ends at one spot, it may point to the seat of obstruction, but this is exceptional. The state of the bowels is of equal importance; constipation may be complete, both as regards fæces and flatus; or there may be a certain amount of diarrhœa, as in fæcal accumulation; and blood and mucus may be passed at frequent intervals with tenesmus, as in chronic intussusception. Vomiting is rarely of much help; unless the attack is acute, so that it is excited by the injuries to the nerves of the bowel, it does not come on until late, and it depends chiefly upon the amount and kind

diagnosis can be based. The prognosis in cancerous stricture is rather longer than in the cicatricial form, so far as life is concerned, probably because, as Treves has pointed out, obstruction does not make its appearance so early.

**Treatment.**—1. *Chronic Obstruction due to Stricture, Peritoneal Adhesions, Volvulus of the Cæcum, Compression, etc.*—So long as the closure is incomplete, relief may be obtained for a time by dieting and by laxatives and enemata. Vigorous purgatives do more harm than good by disturbing the orderly action of the intestine and hurrying down a mass of semi-digested material on to the face of the stricture. The object is to nourish the patient as well as possible without increasing the amount of indigestible material or rendering the fæces hard. In the small intestine this is tolerably easy for a time, and partly by restricting the diet to small quantities of liquid food given at long intervals, partly by nutrient enemata, the strength may be maintained for a considerable period, especially if it is economized by warmth and avoidance of exertion. When the large intestine is involved, this is not so easy, but a great deal may be done at first by means of enemata of hot water with some alkali to soften the fæces and stimulate the walls of the bowel. Not unfrequently a stricture that has been impermeable by the impaction of a mass of fæces in its orifice, may be entered without difficulty from below, and the intruding substance displaced, and perhaps softened sufficiently to relieve the obstruction for the time.

Opium is invaluable for the relief of pain, as in acute cases, and prevents to a certain extent the severity of collapse, but it has little or no influence on any of the causes of obstruction mentioned above, and obscures the symptoms to such an extent that, when it has been given, full allowance must be made for it.

If the obstruction is complete, or if, in spite of all precautions, the abdomen is becoming more distended, and the attacks of colic more frequent and more severe, it is of no use delaying further; if any operation is required, it should be done before the patient is exhausted.

(*a*) *Where the Seat of Obstruction can be Diagnosed.*—If it is in the small intestine, the abdomen must be opened in the middle line, and the cause dealt with, according to its nature and the condition of the patient. In some cases, relief may be obtained by dividing adhesions and so releasing the bowel, but in the majority the choice lies between enterostomy, short-circuiting with Senn's plates, and resection. Of these, the former is more simple, and, if a large extent of bowel is involved, is the only one admissible: but it can, of course, only be regarded as a palliative, and is useless, unless the seat of obstruction is low down in the ileum. Resection alone can give permanent relief, and the condition of the bowel and the strength of the patient must decide whether it should be performed at once or postponed until an artificial anus has been formed.

The rule is the same in the case of the large intestine; if the seat of obstruction is known, the bowel should be opened at the most convenient spot above; or, if it is a malignant stricture, an attempt may be made to excise it, and either form an artificial anus, or suture the two ends together, according to circumstances. Compression by external tumors is an exception; in these cases, special treatment is required.

(*b*) *Where an Exact Diagnosis Cannot be Made.*—If the situation is entirely unknown, median laparotomy must be performed as an exploratory measure, and the obstruction dealt with according to what is found. The colon or cæcum may be opened and stitched to the skin, or the wound closed and colotomy performed later on. When, however, the balance of evidence points distinctly to the large intestine, without the exact site being indicated, the colon should be opened in the right loin or in the right iliac region. If the bowel is found not to be distended, temporary relief may be obtained by opening the nearest and most prominent loop of small intestine.

2. *Fæcal Accumulation, with Loss of Power of the Wall of the Intestine.*—Unless acute symptoms, such as vomiting and prostration, indicative of ileus, set

in, this should be treated with laxatives and enemata. Lumbar colotomy must be regarded, according to Treves, rather as a surgical misfortune than as a recognized method of treatment.

A siphon apparatus is better than a syringe, as the pressure is more uniform. The patient should be placed so that the abdominal muscles are relaxed as far as possible, and warm water, with soap or oil, allowed to flow in gently until by degrees the whole of the colon has been washed out. It may be cleared thoroughly as far as the cæcum; there is no fear during life of any quantity of fluid passing beyond. A little turpentine may be used, if a more stimulating injection is required.* Massage, kneading the abdomen in the course of the colon, and electricity are sometimes of benefit in these cases. The faradic current is used, and one pole is placed on the abdomen or the dorsal spine; the other, properly insulated, in the rectum.

3. *Chronic Intussusception.*—Here, as in the acute form, opium should be given at once to check the increase of the invagination, and to delay the onset of strangulation and inflammation. Then an attempt must be made to reduce the bowel by means of enemata given with great care, and combined with massage under an anæsthetic. Reduction has taken place even at the end of a month, but, as Treves has shown, adhesions, as a rule, very soon make their appearance in cases that are left to themselves. If enemata fail, the only course left is laparotomy, and, if reduction cannot be effected then, either resection, short-circuiting, or the formation of an artificial anus.

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## SECTION V.—PERITYPHLITIS; PERITONITIS.

### PERITYPHLITIS.

Inflammation of the cæcum and appendix is common in young adults, especially males. It may be simple or suppurative. The former merely leads to thickening and condensation of the tissues around; the latter ends either in a perityphlitic abscess, or in general peritonitis. Suppuration may begin outside the bowel, in the inflammatory exudation (forming sometimes a secondary communication with the intestine); but, probably, in most cases, it is the result of perforation (nearly always of the appendix), especially when its onset is instantaneous, without any warning.

**Causes.**—The simple form, like colitis, usually arises from the accumulation of scybala, and remains limited to the mucous surface. Occasionally, the inflammation is more severe, involving the whole thickness of the wall, and then the serous covering becomes affected.

The perforative form may be due to ulceration (the stercoral ulcers of old intestinal obstruction, or those resulting from tubercle, syphilis, or dysentery, for example); to the presence of foreign bodies, such as fish bones; or to the appendix becoming blocked. When this occurs, whether it is due to cherry stones, dried fæces, the presence of adhesions, or any other cause, the secretion accumulates, the tension grows higher and higher, inflammation sets in, and, unless the obstruction gives way, ulceration follows, and ends in perforation.

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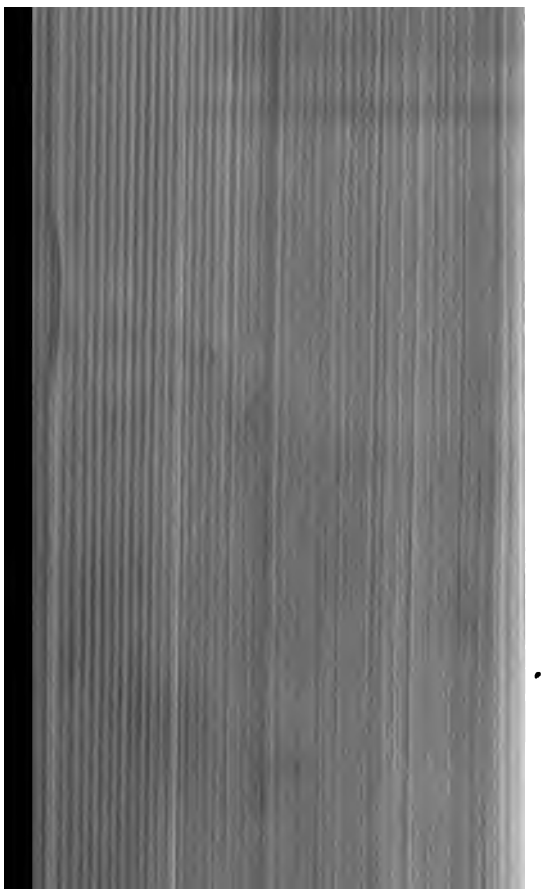
* Hutchinson's description of massage of the abdomen, in cases of intestinal obstruction, is as follows: "The first point in abdominal taxis is the full use of an anæsthetic, so as to obliterate all muscular resistance. Next (the rectum and bladder being supposed to be empty), the surgeon will forcibly and repeatedly knead the abdomen, pressing its contents vigorously upward, downward, and from side to side. The patient is now to be turned on to his abdomen, and in this position held up by four strong men, and shaken backward and forward. This done, the trunk is to be held, feet uppermost, and shaking again practiced directly upward and downward. Whilst in this position, copious enemata are to be given. The whole proceedings are to be carried out in a *bonâ fide* manner. Half an hour or more is to be spent in the process."



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operations, in which the patient becomes cold and collapsed, and dies within forty-eight hours, from acute blood poisoning, without any visible sign of peritonitis). Others irritate the surface, so that exudation takes place instead of absorption. In this case the future course depends upon the surrounding conditions; if the injury is very extensive, death may occur from shock; if less severe, the lymph that is poured out around the affected area either becomes organized, or, if pyogenic irritants gain access to it, breaks down into pus.

(*b*) Organic irritants may be either specific or non-specific. The tubercle bacillus is by far the best known example of the former, and tubercular peritonitis will be dealt with separately. Syphilitic peritonitis rarely occurs, except as a result of extension from neighboring organs, such as the liver, and presents no special features.

The non-specific organisms may be pyogenic or not. Of these the latter are not capable of causing peritonitis so long as the surface of the membrane is uninjured; if, for example, putrid fluid, containing only the organisms of putrefaction, is injected into the uninjured peritoneal cavity, death will ensue from septicæmia if the quantity is large enough, but if it is small the whole may disappear without exciting any local irritation. The constitutional effect depends entirely upon the dose, and it is practically the same whether the fluid is injected into the blood-stream at once, or allowed to find its way in through the peritoneal cavity, and it follows nearly as quickly in the one case as in the other.

Even the pyogenic organisms, according to Grawitz, can only cause peritonitis under special conditions: when, that is to say, the amount of fluid injected with them or poured out by the injured surface is so great that the germs are produced more rapidly than the tissues can deal with them; or when the surface of the peritoneum is injured and the subepithelioid layer exposed. In many instances the inflammation was found to have spread from the prick of the needle that had been used for the injection.

Unhappily, these conditions are of common occurrence. Infected wounds, rupture of the viscera, perforation of the intestine, bursting of a hydatid cyst or of an abscess, and communication with a neighboring cavity, such as the Fallopian tube in a case of metritis, present in abundance everything that is required for the development of acute suppurative peritonitis. There is a sufficient amount of nutrient fluid for the growth of the germs, or if there is not it is poured out at once by the irritated peritoneum; the epithelioid surface is injured over a wider or smaller area by the fluid that bathes it; absorption is checked, and myriads of pyogenic organisms can make their way in from the intestine, through the wound, or even through the blood stream.

(*c*) Peritonitis due to extension from the parts around varies naturally with the primary cause; as a rule it is protective in character, and leads to the formation of adhesions.

Whether cold can be regarded as a cause is uncertain; there can be no doubt, however, that it predisposes to it by lowering the vitality of the tissues and rendering them more susceptible.

**Symptoms.**—Clinically, peritonitis may be sthenic or asthenic in character. The latter occurs when the strength of the patient is overcome by septicæmia, typhoid fever, or Bright's disease.

In the sthenic form the symptoms are very striking. They may be a succession of chills or a rigor; the temperature rises at once; the pulse becomes peculiarly hard and rapid, and the respiration hurried and very shallow. The abdomen may be retracted at first, but very soon it begins to swell over the affected spot, and, in a short time, the whole becomes tense and hard, the muscles are absolutely rigid, the diaphragm is pushed up as far as it can go, and the least touch causes the most fearful pain. The patient lies on the back with the knees drawn up; the face becomes pinched and anxious, the eyes sunken, and the tongue dry and brown; vomiting with hiccough is very common, and usually the fluid is poured up in gushes almost without effort. Constipation is almost invariable,

and the amount of urine secreted is very small. Toward the end the temperature may fall, and the patient sink into a state of collapse; sometimes this occurs almost with the first onset of the disease.

In the asthenic form the constitutional symptoms are more prominent. The abdomen may or may not be distended, sometimes it moves with respiration; pain is felt on pressure; but there is not the intense tenderness characteristic of the sthenic variety. The pulse is very small and weak, the temperature subnormal, and the collapse profound from the first. *Post-mortem* there are no adhesions between the coils of intestine and no lymph on the serous surface, merely a small quantity of a turbid, intensely poisonous liquid.

**Treatment.**—It used to be the rule in every abdominal operation to give opium in order to keep the intestines quiet and prevent peritonitis. Now it is recognized that while opium is essential when the walls of the intestine have been injured, and is of great value in localizing inflammation, it can do nothing to prevent it; indeed, by assisting the distention of the intestine, and still further impairing the muscular tone of its wall, it may actually intensify the evil it is intended to check. For this reason, Wylie, Tait, Greig Smith, and others recommend a saline purge after abdominal operations if fluid is collecting in the pelvis, or if there is a rapidly increasing distention of the abdomen, with restlessness and vomiting. The tympanites is an additional cause of obstruction and vomiting; opium only encourages it; a purge, on the other hand, followed by a turpentine or hot-water enema, will carry off immense quantities of gas and fluid, and relieve the congestion of the abdominal vessels. Afterward the beneficial effect may be continued by the frequent use of the rectum tube. The vomiting that is consequent upon an anæsthetic may be checked by allowing the patient to suck one or two small fragments of ice (not more); if it continues, particularly if there are other signs of peritonitis and the straining is very severe, a cupful of hot water is much more serviceable, and occasionally the stomach may be washed out with advantage.

If in spite of this the symptoms grow worse, or if it is clear from the first that it is a case of perforated peritonitis, the only hope lies in giving free exit to the poisonous fluid. It is true that the condition of the patient is almost desperate, and that shock is much more severe when the peritoneum is inflamed; but if the serous cavity is unable to deal with the poison that bathes its surfaces, steps must be taken first to prevent any more entering, and then to get rid of that which is already there.

Greig Smith recommends the injection among the intestines of boroglyceride solution, an ounce to the pint, at a temperature of 102° F. It should be slowly forced into the cavity among the intestines through a drainage tube, and compelled to remain there for a time by temporarily plugging the orifice; and this may be repeated several times a day.

Mikulicz distinguishes between diffuse peritonitis, due to a large amount of the contents of the intestine being poured suddenly into the cavity, and a progressive form which is localized at first. The former can only be treated by a free opening and washing out the cavity with hot salt and water, or hot boracic solution, until it is thoroughly cleansed. The latter, on the other hand, may remain localized for a time, and if the situation of the successive foci can be made out, they may be opened and drained separately, taking great care not to disturb any of the adhesions. Thorough drainage of the peritoneal cavity is almost impossible, but the attempt has been tried by making numerous openings in the middle line and in the flanks, and by passing across as many as eight large perforated tubes through which a current of hot salt solution could be sent.

When the suppuration is localized already, the prospect is much more hopeful; there are already many instances on record in which purulent collections, consequent on intestinal perforation, gonorrhœal inflammation, and other causes have been successfully drained.

### Tubercular Peritonitis.

A large number of cases of encysted tubercular peritonitis have been relieved and not a few cured by free incision. Even when the disease is part of a general tuberculosis a certain amount of benefit may be obtained without in any way hastening its progress. In the earlier cases the diagnosis was not made until the cavity had been incised, and from the extreme difficulty of distinguishing between some of these forms of encysted ascites and ovarian and other cysts, the same mistake is not unlikely to occur again. In a fair proportion of cases the diagnosis has been verified by the microscopic examination of the miliary growths and the discovery of bacilli.

Primary peritoneal tuberculosis (the class of disease for which operation is most suitable), is probably not common; nearly always it is secondary, but as there is evidence to show that the partial removal of tubercular foci in other parts of the body is sometimes beneficial, the patient appearing to make better headway against the rest, and as considerable relief may not unreasonably be expected to follow the removal of a mass of this character from the abdominal cavity, operation is not negatived by this, provided the disease is not too far advanced. Whether anything more than simple drainage is advisable is uncertain; probably it would depend to a large extent upon the size of the cavity and the character of its walls.

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## SECTION VI.—OPERATIONS UPON THE INTESTINES.

### Enterostomy.

This is sometimes known as Nélaton's operation. A small incision is made in the abdominal wall, an inch and a half or two inches in length according to the thickness; the peritoneum is incised, and the most distended loop of small

Fig. 400.—Inguinal Wound Made in Nélaton's "Operation of Enterostomy."

intestine that lies near is drawn into the wound and fixed with sutures. If the case is urgent and the bowel must be opened at once, very accurate and very firm adaptation is necessary, as in such cases there may be a considerable amount of movement as soon as the pressure is relieved. The parietal peritoneum may be drawn outward and fixed to the skin by two or three sutures; and then four, or better six, silk threads must be passed through the united layers, the visceral peritoneum, and the outer coats of the bowel. One or two catgut sutures may be used between the others for greater accuracy. The opening in the intestine should

be merely a puncture. Escape of the contents may be best prevented by covering the edges of the wound with an antiseptic ointment and using the aspirator.

Where it is possible, it is advisable to divide the operation into two stages, stitching the bowel into position first; and two or three days later, when adhesions have formed between the peritoneal surfaces, making the opening into it, and if necessary securing it by further sutures.

As originally performed by Nélaton, the operation was in the right iliac fossa, between the deep epigastric artery and the anterior superior spine of the ilium; and the portion of bowel opened was the small intestine immediately above the cæcum. It may be done, however, in the middle line or in the right lumbar region, if it is found when the colon is exposed that the seat of obstruction is higher up.

As a primary operation enterostomy meets with but little favor. The cases of obstruction in which distention of the bowel is the only cause are very few in number; these may be cured by such an operation, and the opening closed. It is, however, as yet impossible to diagnose them from other forms of intestinal strangulation in which the operation, if it were performed, would merely give momentary relief, leaving the real source of the mischief untouched. On the other hand, when the colon has been exposed and found empty, or when laparotomy has been performed and some hopeless condition discovered—an irreducible and extensive intussusception, for example—or widely spread carcinoma in a patient who is completely exhausted, enterostomy may prove of the greatest service by relieving distention and pain and prolonging life.

Greig Smith recommends that in cases of intestinal obstruction in which the patient is much collapsed, this operation should be performed under local anæsthesia by the subcutaneous injection of cocaine, merely to give time to rally. Even if nothing is given the pain of the incision is scarcely felt, and any other anæsthetic, increasing the depression or causing vomiting, would almost certainly extinguish the little chance that is left.

## COLOTOMY.

The colon may be opened either in the lumbar region on the right or left side, or in the left inguinal. In the former operation, which was first performed by Amussat on the right side, the posterior surface of the bowel where it is uncovered by peritoneum is, generally speaking, exposed; in the latter (Littre's) the peritoneal cavity is always opened.

## LUMBAR COLOTOMY.

The colon is placed half an inch behind the middle of the crest of the ilium, as measured between the anterior and posterior superior spines, lying upon the quadratus lumborum, immediately below the kidney. If it is distended there is usually a considerable surface uncovered by peritoneum; when it is collapsed this contracts; but the sides may generally be separated from each other, and the bowel reached without interfering with the serous surface. In a certain proportion of cases, however, a meso-colon is present, especially on the left side (Treves), and then it is impossible.

The patient is placed on the opposite side, almost semi-prone, with a hard, round pillow under the loin to separate the last rib from the ilium. The margin of the erector spinæ is defined, and an incision, two and a half to three inches in length, is made obliquely upward and backward toward the angle enclosed by the last rib and the spine. The middle of it should correspond to the spot at which it is expected the bowel will be found. Practically, unless the last rib is much depressed, the incision is parallel to it and the arteries, and lies in one of the natural folds; but care must be taken not to bring it too near the crest, or one margin will sink below the other.

The latissimus dorsi, with a few fibres of the external oblique, and the internal oblique are divided first and all hemorrhage stopped. The fascia lumborum is slit up on a director for the whole length of the wound and the outer border of the quadratus exposed. A quantity of loose fat, in which the kidney is embedded, and the transversalis fascia at once come into view, the latter in some cases closely resembling the peritoneum in appearance. This must be teased through gently with forceps, the bleeding stopped, and the finger introduced to ascertain the position of the kidney. If the bowel is distended, the non-peritoneal surface generally rises into the wound at once, so that there is no difficulty. If it does not, the bowel may be filled with air from the anus by means of Lund's insufflator, but this is rarely required. As a rule, it is sufficient to pass the finger down into the angle between the quadratus and psoas, dividing the edge of the former a little if it is necessary, and by rolling the patient over to the left side allow the bowel to fall against the digit. The intestine should now be hooked well forward into the wound, the sides of which are held apart by retractors, in order to make certain that the portion exposed is really the colon. This is especially necessary on the right side; it has happened to several of the best operators to open the loop of the duodenum by mistake. If it is full of hard scybalous fæces, or if one of the appendices epiploicæ can be recognized, it is usually sufficient; but the only absolutely sure test is the presence of a band of longitudinal fibres, and when the non-peritoneal surface is exposed these are remarkably inconspicuous. Allingham, junior, who found an ascending and a descending meso-colon in five-sixths of the cases he examined, considers it advisable, unless the intestine presents itself in the wound, or can be recognized beyond all doubt at once, to open the peritoneal cavity, and by introducing the finger, or if the colon is much displaced, the hand, to find the portion of bowel required and bring it up to the surface. The cut edge of the peritoneum is then to be stitched to the skin so as to shut out the abdominal muscles from the wound, and the bowel secured in position.

When the intestine must be opened at once, a large curved needle is passed through the skin on one side of the wound, across the bowel, and then through the skin from within outward upon the opposite side again. The same thing is done with another needle about an inch lower down. The ends of these sutures are to be held by an assistant. A small puncture is then made with a tenotomy knife in the centre of the square so marked out, and the two threads, as they traverse the interior of the bowel, are caught up and pulled out in loops by means of an aneurysm needle. As soon as the loops are cut, the bowel is held up against the skin, slightly overlapping it, by four silk sutures passing through its whole thickness. Additional security may be obtained by passing other sutures where required, either to hold the bowel to the skin, or to bring the angles of the skin wound together; and often it is advisable to place a series of buried catgut sutures in the wound to close, as far as possible, the planes of cellular tissue between the muscular strata.

FIG. 401.—Method of Securing Bowel in Lumbar Incision.

Whenever it is possible the opening of the bowel itself should be postponed; union by the first intention may make everything secure within three days, and prevent all fear of fæcal extravasation and suppuration, and an interval of only a few hours can appreciably diminish the risk. The intestine may be secured in position by sutures passing through its muscular wall only, the mucous membrane being carefully avoided, or by means of Howse's forceps, which are made to grasp small folds of the muscular coat at intervals of about half an inch, and are then laid flat upon the skin and kept in position by broad strips of plaster.

In any case, it is absolutely essential to draw the bowel well up into the wound, so as to form a spur on its deep surface and prevent the fæces passing beyond; unless this is done the relief is exceedingly imperfect, and fæces may collect in the part below, and give rise to serious inconvenience. Madelung, to obviate this, and to prevent the irritation of fæces passing over a cancerous surface, has divided the bowel completely, sutured the upper end to the lumbar wall, and completely closed the other; but, as Greig Smith points out, this is open to the objection that, if the stricture becomes closed, there can be no escape for the foul and decomposing discharges in the lower segment. When the opening is a considerable distance above the seat of stricture, and the bowel is much distended, it is of advantage, as soon as the parts are fairly firm, to introduce the tube and gently wash out the accumulation from below. Afterwards the spur ought to be sufficient to prevent anything more passing on.

FIG. 402.—Artificial Anus after Colotomy with the Oblique Incision.

The discharge of fæces is generally easy; exceptionally, when there are scybala, it may be necessary to wash them out, or even to extract them with forceps. The only dressings required are wood-wool, or some other absorbent antiseptic material in large pads, changed as frequently as necessary, and some zinc or boracic ointment around the margins of the wound. Afterwards an apparatus must be worn to support the opening and collect any fæces that may escape. Ivory or india-rubber rings may be used, fixed to an abdominal belt so that there is a certain amount of pressure, as well as tension, around the opening; but in many cases patients find the greatest amount of convenience from absorbent pads covered on the outer surface with oiled silk, and secured by a linen binder.

### INGUINAL COLOTOMY OR LAPARO-COLOTOMY.

This is performed in the left inguinal region, but when it is desired to open the cæcum or ascending colon, a similar operation may be carried out on the right side.

Various incisions are recommended, but in the majority of instances one two inches in length, parallel to Poupart's ligament, and about one inch inside the anterior superior spine, fulfills all requirements. Ball prefers the linea semilunaris, as there is no muscular substance divided. All bleeding must be stopped before the peritoneum is opened. As soon as this is done the finger is introduced and passed along the lower margin of the iliac crest until the mesentery guides it to the sigmoid flexure, and its condition, with regard to distention and the situation of the stricture, is ascertained. The parietal peritoneum is then sutured to the skin, so as to exclude the muscles of the abdominal wall, and a loop of intestine, with a sufficient length of mesentery, is pulled out and secured. The simplest way of forming a spur is that devised by Allingham, junior. A needle, threaded with carbolized silk, is passed through the meso-colon behind the bowel, and

through the whole thickness of the abdominal wall on either side of the opening, so as to sling the intestine up and bring its posterior wall forward. The sides of the intestine are then fixed all round to the margins of the skin by silk sutures passing through the muscular and serous coats only, and leaving at least two-thirds of the circumference of the bowel protruding between the rows. A few hours' delay in opening the intestine is even more essential here than in the lumbar operation.

Ball recommends that a loop of intestine should be pulled out through the wound, emptied as far as possible, by gentle pressure, and secured for the time by clamps placed above and below, so that no fæces can escape when it is opened. A series of sutures is then passed through the whole thickness of the abdominal wall on either side, and across the bowel between the clamps. One should pass through the meso-colon in the angle of the loop, and three or four through the bowel above and below. When these are placed in position the convexity of the bowel is opened, the mucous surface carefully cleansed, and the threads fished out, divided, and secured, with the exception of the outermost one at either end. The mucous membrane is adjusted all round, the angles of the wound brought together, leaving the handles of the clamps still protruding, and then at last, when everything is secured, the clamps are withdrawn, one at a time, and the opening closed instantly by tightening up the sutures that have been left. In this way the upper and the lower ends of the loop are fixed securely side by side, and no escape of fæces is allowed until the clamps are unscrewed. When the bowel must be opened at once this plan presents considerable advantages over the other; but great care is necessary to secure it sufficiently firmly without bruising it, especially as the walls are not unfrequently much softened and congested. Redundant portions of the bowel can be removed with scissors afterward, as far as may be necessary, without its being felt.

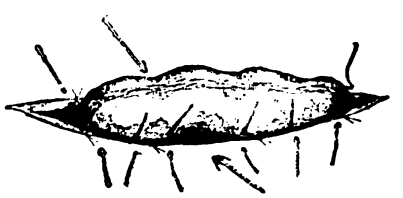


FIG. 403.—Method of Securing Bowel in Inguinal Incision.

[In Maydl's operation, incision is made parallel with the fibres of the external oblique muscle. The colon is drawn into the wound, and a glass rod wrapped with iodoform gauze, thrust through the mesentery underneath the loop; the gut is then stitched under the rod on each side. If considered necessary to open the colon immediately, the peritoneum of the abdominal incision is stitched to it, and the incision covered with iodoform collodion. If it is intended to open the colon in four or five days the wound is well packed with iodoform gauze. When ready the colon is opened by the Pacquelin cautery and drainage tubes inserted into each bowel opening. Through these tubes irrigation can be effectively carried on, and the action of the external oblique muscle takes the place of a sphincter. The accompanying figures from Esmarch ("Chirurgische Technik") will render further description unnecessary.]

### INGUINAL *v.* LUMBAR COLOTOMY.

Little reliance can be placed upon the older statistics, which give the former of these operations a much higher rate of mortality than the latter. More recent experience tends to show that, so far as this is concerned, if there is any material difference, the balance is rather on the other side.

In a certain number of cases lumbar colotomy is almost impossible: a fæcal fistula may be formed in the loin, sufficient so long as the bowel is immensely distended; but when there is no meso-colon, and the walls are perhaps four or even five inches in thickness, it is not possible to draw out the bowel sufficiently. The peritoneal cavity, it is true, is always opened in the one, but it very often is in the other, and sometimes without its being known. The inguinal operation is shorter,

and the wound much smaller; the large intestine can be found more easily, and can rarely be mistaken; the seat of stricture can often be ascertained, and it is always possible to make sure that it lies below the wound. So far as the after treatment of the case is concerned, there is no question as to the side upon which the advantage lies: the tendency to prolapse may be slightly greater in the inguinal region, but it is easily controlled, and the patient can attend to himself much better. The only exception is where the bowel is very greatly distended and the walls much thinned; then it is probable that the immediate risk is less in the case of the lumbar than the inguinal. The actual distance between the two openings is not more than four inches, so that very little is gained in this respect by the lumbar incision.

FIG. 404.—First Stage of Maydl's Operation for Artificial Anus. (*After Esmarch*)

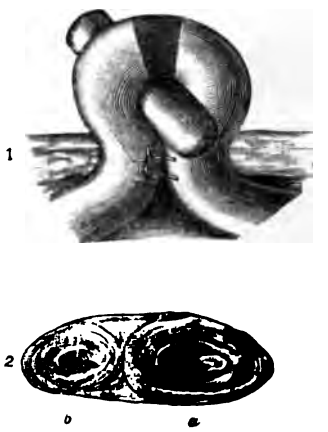



FIG. 405.—1. The Intestinal Loop drawn forward.
2. Completely severed.
(*a*) Conveying; (*b*) Discharging End.

Prolapse of the mucous membrane of the bowel is more frequent after the inguinal than the lumbar operation, but this may be prevented to some extent by drawing down the sigmoid flexure as far as possible and fastening in the wound the highest part that can be reached.

It must not be forgotten that patients who are suffering from abdominal distention and are worn out from intestinal obstruction, frequently take anæsthetics badly, and that the position necessary for the lumbar operation still further impedes their respiration.

## ENTERECTOMY.

Resection of the small intestine may be performed when the condition of the bowel is hopeless from gangrene, irreducible intussusception, or matting together and bending; for stricture, simple and malignant; for perforating wounds, or as a plastic operation for the cure of artificial anus. If the condition of the patient and of the wall of the intestine is such as to admit of it, the two ends may be sutured together and returned into the abdominal cavity at once. In other circumstances an artificial anus must be formed, and left to be dealt with later on.

The operation, following Greig Smith, is conveniently divided into three steps: (1) the isolation of the bowel, so that it can be drawn out of the abdominal wound and emptied; (2) the resection; and (3) the suturing of the ends, either to each other (enterorrhaphy) or to the wall of the abdomen.

1. *Isolation.*—In most instances there is but little difficulty in part that is gangrenous or has been wounded can generally be drawn outside and thoroughly

examined. More preparation, however, is required when there is an artificial anus: the abdomen must be opened above and below, the orifice of the bowel closed, and the adhesions carefully dissected off; and in the case of malignant stricture very strict examination is necessary to make sure that the whole of the growth can be taken away. One or two glands may be removed, but if there is any extensive infiltration, or if the intestine is adherent, the attempt is not likely to succeed. As soon as the bowel is drawn out, it is laid upon a flat carbolized sponge, and the opening into the abdomen packed with more sponges to prevent the intrusion of fæcal matter and the escape of more of the intestine.

2. *Resection.*—As soon as the bowel is safely held away from the margin of the wound, it should be opened and encouraged to empty itself as far as possible. Whether it should be secured above and below with clamps, or merely held with the fingers, depends, to a large extent, upon the condition of the bowel itself and upon the character of the assistance at hand. The more instrumental compression can be dispensed with the better, but it must be allowed that nothing can prevent the escape of the contents more effectually or maintain the cut edges in better apposition for the application of the sutures. Many forms have been devised, and something may be said in favor of nearly all, but perhaps the simplest is that adopted by Makins. It merely consists of a pair of spring-catch forceps with longer blades than usual, and a screw so that they can be tightened to any required extent. The blades are covered with rubber tubing to avoid injury to the coats of the bowel.

If the portion of the bowel to be removed is of any length (in Koeberlé's case the amount was over two yards) a triangular segment of mesentery to correspond must be taken away to prevent kinking afterward. The base of the triangle should be rather smaller than the interval between the ends of the intestine, so as not to interfere with their blood-supply, and the raw edges must be adjusted to each other by means of a continuous catgut suture carried over and over the margins. In most cases, however, this is scarcely necessary; the folds may be drawn together and the base so formed stitched to the intestinal walls. The line of section through the mesentery should always be carried as close to the attached margin as possible, to preserve intact the row of anastomotic loops from which spring the vessels supplying the wall itself. Any part of the intestine separated from this is sure to slough. MacCormac recommends that the section through the bowel should not be exactly transverse, but that rather more should be removed on the convex side, as by this, after the suturing is complete, the tube remains somewhat straighter.

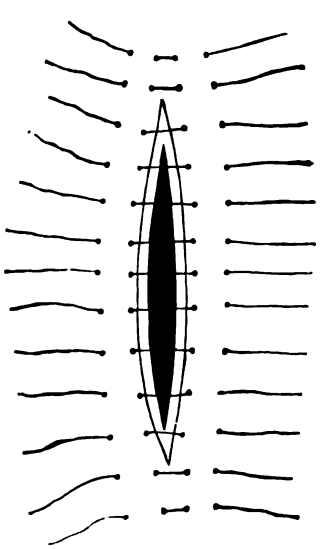


FIG. 406.—Lembert's Suture.

3. *The Suturing.*—A great variety of intestinal sutures have been described, but the essential features are: (1) that the peritoneum should be in contact over a sufficiently broad surface; (2) that no suture traversing the mucous membrane should pass at once through the serous coat as well, or it will inevitably act as a seton, carrying the contents into the peritoneal cavity; if sutures are used to bring the mucous edges together, they should be independent, and tied on the mucous surface, so that if there is any ulceration they may fall into the cavity of the bowel; (3) that the sutures should be sufficiently close (eight to the inch at least) and pass sufficiently deep to secure a firm hold. Each should take up the serous layer, the whole thickness of the muscular wall (which is much thinner in the ileum than the jejunum), and a few fibres of the submucous coat. Especial care is necessary when working near the attachment of the mesentery, as the serous

layer at this spot is separated by a cellular interval from the structures beneath, and it is nearly always here that extravasation occurs. The last requisite is that the method should be one capable of rapid application.

Fine China twist is the best material, and one row of sutures at least should be interrupted, taking care that they are not sufficiently tight to cause sloughing. Continuous sutures are admirably adapted for securing contact and for strengthening weak places; moreover they prevent over-distention of the bowel, but if it contracts they become loose at once.

Treves advises that there should be two rows: one through the mucous membrane, which, as soon as the bowel is divided, becomes everted; and a second, further back, turning this in again, through the serous and muscular layers. For the latter, Lembert's is the most useful; the needle is entered about three to three-and-a-half lines from the margin, passed down through the serous and muscular coats until the resistance of the submucous layer is felt; and then, after picking up a few fibres of this, brought up again about one line from the cut edge, and introduced into the opposite end of the bowel in the reverse direction. Czerny combines Lembert's with another row inside, passing, not through the mucous membrane only, but through the whole thickness of the bowel.

FIG. 407.—Lembert's Suture Tied.

One or two sutures should always be passed across the cut edges of the mesentery immediately above its attachment, in order to obliterate as far as possible the triangular space that normally exists there, and allow all the sutures to pass through the serous coat. Greig Smith speaks very highly of Halsted's plain quilt suture, and makes a most ingenious use of it.

"The intestine has been cut away, the mesentery divided as close to the bowel as deemed desirable, and no wedge-shaped portion removed. Two Makins clamps, covered with rubber tubing, have been applied, at a distance of about half an inch from the divided ends of the bowel. A purse-string stitch has been so arranged along the divided margin of the mesentery that it draws together the gap of cellular tissue and the attached margins of gut, while it leaves free small flaps of peritoneum, which may be grafted on to the base of the line of union. Four quilt sutures have been inserted on the opposite sides of the divided gut, in the exact line in which the Lembert sutures are to be placed; the two on each side are to be gathered together in the blades of catch-forceps, and gentle and steady traction made on them by an assistant. This raises a well-defined fold along the edge of the bowel: into this fold the sutures are inserted. The traction on the quilt-stitches makes certain that equal distances of the bowel are arranged for suturing, and also, by raising a fold, makes the insertion of Lembert's stitches more easy and ensures their being placed in a straight line." The quilt-sutures are tied the last of all, and, finally, any redundant mesentery is fixed along the line of union of the bowel. Any spot that appears weak may be strengthened by Dupuytren's or Appolito's continuous suture applied outside.

Senn ("Annals of Surgery," 1888), who has performed on animals an invaluable series of experiments, prefers a modification of Joubert's suture where direct union of two cut ends is required. The time is very much shorter; there is less danger at the mesenteric edge; the number of sutures is smaller, the risk of their giving way prematurely and of their perforating the mucous membrane is not so great, and there is not so much fear of gangrene.

The direction of the bowel is first ascertained by Nothnagel's test (a crystal of a sodium salt placed upon the serous surface, causing ascending peristalsis), the upper end, which is to become the intussusceptum, is lined with a soft pliable rubber ring (made from a flat rubber band, one-third to one-half of an inch in width, by securing the two ends together with catgut sutures), which is stitched to the wall at its lower edge with a continuous catgut suture. The two ends of the bowel are then fastened together with four catgut sutures, placed at equal distances,

and the upper one, supported by the ring inside, is pushed into the other so as to invaginate it. The intussusceptum must be a little longer than the ring, so that there may be a distinct neck which can be grasped by the intussuscipiens. A few superficial sutures are required to prevent disinvagination.

The ring acts as a splint, keeping the part at rest, and its pressure (which must not be too great) is useful in securing the apposition of the serous surfaces. When the catgut softens it comes away of itself.

There is no doubt that by this process the operation may be performed in less than one-fourth the time, and that in animals it succeeds perfectly. It must be remembered, however, that the human intestine is of larger calibre, and its walls for the most part thinner. Probably it would not succeed in cases of obstruction where the upper part of the intestine is filled with fæces, or its walls much softened and congested. For such the formation of an artificial anus is to be preferred. In perforating wounds, however, where perhaps several resections have to be performed, the gain in point of time alone would be of immense advantage.

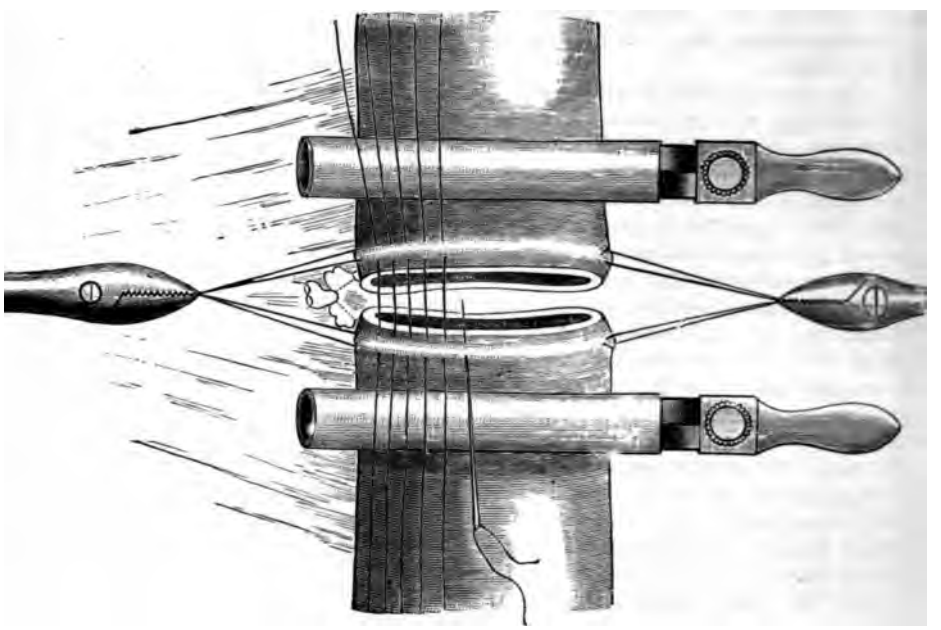


FIG. 408.—Drawing to Show Method of Intestinal Suture. (*Greig Smith.*)

Senn has also practiced a most ingenious system of omental grafting, both in ordinary cases of circular suturing and in his modification of Joubert's method. A flap about an inch in width (or a little more), and sufficiently long to reach round the bowel, is taken from the margin or the middle of the omentum, and laid upon the line of junction; two catgut sutures are used to fasten it, each passing twice through the flap (once at its base and once at its free end), and through the mesentery of the bowel in between, care being taken that when the sutures are tied they correspond in direction to the course of the mesenteric vessels. At first the attachment of the base of the flap to the omentum was preserved intact; but in his later experiments, owing to the possible objection that kinking might be produced by this, perfectly isolated strips were used and succeeded equally well. Slight scarification of the serous surface, not sufficient to cause bleeding, is, according to the same authority, of additional advantage in securing early and firm adhesion of the coats.

Where it is not advisable to return the bowel into the peritoneal cavity, the

two ends are sutured carefully to the skin around the abdominal wound. A few stitches should be put in first to connect the parietal peritoneum to the skin and exclude the muscles, and the external opening closed as far as possible; then the muscular and serous coats of the intestine are fastened with silk at as many points as may be necessary all round to the conjoined peritoneum and skin. If the bowel has not been emptied, but merely the contents prevented from descending by means of a clamp, this should not be removed until everything is secure, for fear of the fæces in their first rush finding their way into the peritoneum.

The peritoneal cavity itself should be interfered with as little as possible, if blood has escaped into it in any quantity it must be sponged out; but all bleeding points should be secured before it is opened, and the section through the bowel (which, owing to the congested condition of the walls, often bleeds freely) should not be made until it can be well isolated. Fæcal extravasation is very much more serious, but even then recovery has followed after the peritoneum has been thoroughly washed out with a hot solution of boracic acid; whether a drainage tube should be used or not must depend upon the amount of peritonitis.

Whether the bowel should be returned into the peritoneal cavity at once and the abdominal wound closed, or an artificial anus formed, must be decided for each case by the condition of the patient and of the intestines. There is no doubt that, for obstruction at least, the former of the two is the less successful, but it must not be forgotten that an artificial anus high up in the small intestine practically means starvation, and that if the patient is to be cured there is all the risk attendant upon the second operation. In case of wounds, where the bowel is healthy and the patient not too much depressed, there is no doubt the operation should be completed at once.

In a few instances an intermediate course has been followed; the bowel has been returned just within the wound and secured in that position by one or two sutures. This may be done if there is any doubt as to the security of the stitches in the bowel, and several cases in which it has been adopted have recovered after a slight discharge of fæces through the abdominal wound.

## COLECTOMY.

Resection of the colon has been practiced in cases of gangrene (upward of fifteen inches of the transverse portion have been excised successfully in umbilical hernia), irreducible intussusception, gunshot injury and stricture; but so far, at least, as malignant disease is concerned, and this is the chief of the causes for which colotomy is performed, the advisability of such a proceeding is very doubtful. It rarely happens that the case is diagnosed, or that such a serious operation is agreed to by the patient in time for complete removal; adhesions are nearly always present, either to the neighboring viscera or to the parietes of the abdomen, and recurrence within a short time is only too probable. As Kendal Franks has shown, the primary mortality is exceedingly high (though the percentage with improved methods is certainly growing smaller), and of those who recover more than half are known to have suffered from a recurrence within a few months. Colotomy can give such complete relief with such small risk, that before colectomy is preferred it must be shown that there is a reasonable prospect of cure.

The operation for the transverse colon is performed through the middle line, and portions of the ascending and descending colon have been removed in the same way, but this must be considered exceptional. As a rule, so far as these are concerned, colectomy is only possible when the seat of disease is opposite the lumbar incision and the bowel is sufficiently free for it to be well pulled out. The method is the same as in enterectomy; peritoneal surfaces must be brought together as far as possible; and where this cannot be done the muscular coats must be accurately sutured, but this greatly increases the risk of suppuration and retro-peritoneal abscess.

### Cæcectomy.

This operation, which is essentially of the same description, has been performed on several occasions, the whole of the cæcum being removed and the ileum joined to the ascending colon.

### Intestinal Anastomosis.

By this is meant the formation of a fistulous opening between two portions of intestine, or between the intestine and the stomach, so as to secure the direct transit of the contents from one to the other. As an alternative to resection and circular suture or implantation it should certainly be preferred in all cases in which it is impossible to remove the cause of obstruction; in which, after resection, continuity cannot be restored without undue traction, and in which the pathological conditions causing the obstruction are not such as of themselves to constitute a danger to life. Its importance in connection with carcinoma of the pylorus alone may be imagined from the fact that, in Lücke's clinic, out of fifty-two cases selected for pylorectomy, only five were free from metastases, and that the mortality of the operation was 75 per cent.

The particular name of the operation depends upon the locality, gastro-enterostomy, jejuno-ileostomy, ileo-ileostomy, ileo-colostomy, etc. The principle is the same in all cases.

#### *Senn's Methods.*

1. *Where the two Segments are Placed Side by Side.*—Decalcified plates of bone, one inch wide by three inches long, are prepared from the tibia of an ox by soaking them in hydrochloric acid; when sufficiently flexible they are washed free from acid, dried between plates of tin so that they may not curl up, and kept until wanted in absolute alcohol. In the centre of each plate an opening is drilled five-eighths of an inch by one-sixth; and around this four smaller holes for sutures, one on each side, one at each end, about one-sixth of an inch from the central opening. The sutures, which are of fine China twist (catgut of sufficient strength is too coarse and the knots too large) are secured beforehand on the inner surface of the plate and passed through the holes to the other side.

A longitudinal incision is made on the convex side of the intestine, away from the mesentery, sufficiently long to allow the plate of bone to be slipped inside and arranged parallel to the bowel, against its mucous surface. The two end sutures are allowed to hang out through the opening; the two lateral ones, which have needles attached to them, are passed through the wall of the bowel, near the incision, so as to fix the plate and prevent eversion of the mucous membrane. A second plate is arranged in a similar way inside the other portion of intestine; and then the serous surfaces are brought together so that the orifices correspond, and the opposite sutures tied. The knots of the lateral ones lie between the peritoneal surfaces.

By this, accurate approximation is secured over a surface corresponding to the size of the plates; there is no risk of cutting off the blood-supply by the multitude of sutures; the plates act as splints and secure perfect rest; and the time of the operation is only fifteen minutes. Senn found that, in dogs, bone-plates, if thoroughly decalcified, were digested too soon in the stomach; but it must be remembered that the gastric juice is much more acid in them than it is in man.

2. *Where the End of one Segment is Implanted into the Side of the Other.*—In this case the proximal end of the distal segment must be thoroughly invaginated and closed with a continuous catgut suture passing through the peritoneal and muscular coats. Senn has shown that if it is treated in this way it soon atrophies and shrinks up, and there is no fear of its becoming the seat of fæcal accumulation.

For this Senn makes use of the modification of Joubert's suture already de-

scribed (p. 944). A rubber ring is secured in the distal end of the proximal segment; two catgut sutures, each provided with two needles, are passed from within out, at opposite sides, through the upper margin of the ring and the whole thickness of the bowel; each needle is then passed into the wall of the colon, about one-third of an inch from the margin of the opening, penetrating the peritoneal, muscular, and submucous coats only, and emerging on the same surface. As soon as they are all secured at corresponding points, gentle traction is made upon them while the end of the proximal segment is pushed into the side of the

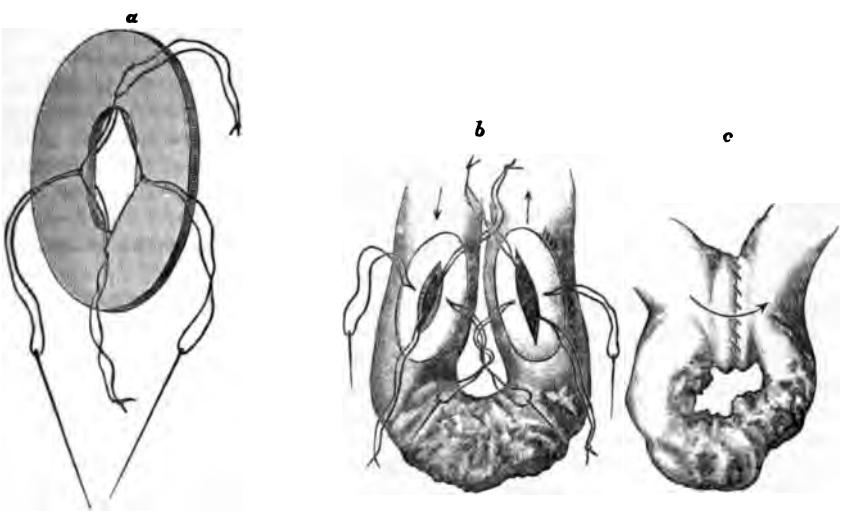



FIG. 409.—Entero-Anastomosis. (*After Senn.*)

distal one, so as to form a limited invagination. The sutures are then tied only sufficiently to prevent any disinvagination. The pressure of the ring keeps the part at rest and secures accurate adaptation, and the invagination prevents any escape of the contents and secures the sealing of the wound. Superficial sutures are not required.

This method, of course, is only applicable where a smaller segment can be implanted into a larger one, and therefore cannot be used in the case of the stomach.

## ARTIFICIAL ANUS AND FÆCAL FISTULA.

In artificial anus there is a free communication between the skin and the bowel, the whole or nearly the whole of the intestinal contents escapes, and the part below shrinks and collapses. In fæcal fistula, on the other hand, the channel is narrow, it may be long and tortuous, and the greater portion of the contents follow the natural route. The one arises from the loss of a loop of intestine, or from destruction of the greater portion of the circumference of a short segment, the bowel being sharply bent upon itself; the other from sloughing of a small part only of the wall.

The most important practical distinction is the existence in the former of a spur or septum opposite the opening, which prevents the contents passing on. The posterior wall of the bowel is pushed forward from behind by the weight of the viscera; a ridge is formed on the mucous surface, and this grows more and more prominent until at length it overlies and closes the opening of the lower segment; the whole of the fæces then discharge themselves externally, and this part of the bowel, from being never used, shrivels up to a narrow cord.

The most common cause is hernia, and for this reason the opening is generally situated in the femoral or inguinal region; but it may arise from injury, carcinoma, internal strangulation, fæcal abscess [tubercular], circumscribed peritonitis, and many other causes; and the communication may be formed with the bladder or vagina, or, in very rare cases, with other parts of the bowel. If the opening is of any size, prolapse of the mucous membrane is almost sure to occur; and, sometimes, owing to the stretching of the adhesions between the two portions of bowel, or between the bowel and the skin, hernial protrusions make their appearance by the side,

**Treatment.**—Where there is merely a fistula, and the passage below is fairly open, the orifice often closes in of itself. The discharge becomes less; the cicatricial tissue round contracts; the patient regains strength (unless the opening is high up in the intestine); and, even if the cure is not complete, the operation is less extensive, and the condition of the patient more satisfactory. This sometimes occurs in that form of artificial anus which follows femoral hernia; and the process may be hastened by pressure steadily applied, by drawing the edges together with strapping, button sutures, or hare-lip pins, or by the use of the actual cautery. Sometimes a small plastic operation will succeed. In most cases of artificial anus, and whenever the orifice is high up, so that the patient is in danger of starvation, further measures are essential.

1. Where the chief difficulty arises from the presence of a spur, an attempt may be made, either to divide it or to press it back. The simplest method is that suggested by Mitchell Banks: a stout piece of rubber tubing, secured by a ligature so that it shall not escape, is passed through the orifice into the upper and lower ends of the bowel, resting against the edge of the spur. The contents of the intestine, especially if the opening is high up, pass through it more or less, and by its pressure it wears the projection back, and brings the two portions into the same line again.

If this fails, and the spur is very distinct, it may be divided by means of Dupuytren's enterotome. This consists essentially of a pair of forceps, the ends of which are broadened out into flattened discs or circles; one of these is passed on each side of the septum, and then, after making sure that there is no loop of intestine caught between, they are slowly and cautiously tightened up from day to day, until at the end of a week the septum sloughs through. Adhesions meantime form around and completely shut out the peritoneal cavity. The mortality attending this procedure is exceedingly low (no more than 8.5 per cent.); but, of course, it is only applicable to selected cases.

2. Where the opening is very high up, and the patient is gradually losing ground; where there is no well-defined spur, and where there is more than one opening, resection and suture of the bowel afford the only hope of cure. This must be done on the principles that have been already described, but even when every precaution has been taken, the mortality, according to Makins, amounts to nearly forty per cent. The patient, for a day or two before, is fed wholly with enemata; the bowels and the skin round are thoroughly cleansed, and an incision is made into the peritoneal cavity to ascertain the amount and extent of the adhesions, and the direction of the bowel. After this, the ends are carefully freed from surrounding structures, drawn well out of the wound (which is immediately plugged with sponges; clamped if necessary, resected, and sutured. If the lower end of the bowel is much contracted, there may be great difficulty in this, and it may be necessary to divide it obliquely so as to secure a full extent of cut surface; but every attempt should be made, both before and during the operation, to dilate it quietly and gradually. Afterwards the bowel is returned into the peritoneal cavity, and the abdominal wound treated as in laparotomy. If there is any doubt as to the security of the sutures, it is well to retain the bowel close to the surface.

**After-treatment.**—The after-treatment of operations upon the intestine is essentially the same as that of hernia; as soon as the patient comes round from the anæsthetic, he must be placed under the influence of morphia and kept tem-

porarily quiet for at least eight days. A little ice may be given to allay thirst, but he must not be allowed to suck it constantly; the temperature must be maintained, and where the upper part of the intestine is concerned, the strength kept up with nutrient enemata. Barker has shown that, in a case of gunshot wound, six days suffice for sound union, but probably the time required in obstruction would be considerably longer. Artificially digested food should be given at first, and in very small quantities. In colotomy, of course, the method is different, and nourishment may be taken by the mouth from the first.

If the bowel has been retained, the wound does not require dressing for five or six days, unless a drainage tube is used, or peritonitis was present. Sometimes a small discharge of fæces takes place for a time, and then gradually ceases, caused probably by the giving way of one or two of the sutures. Where an artificial anus is left, large absorbent and antiseptic pads should be used and changed as often as required, the skin being protected, as far as possible, by vaseline or simple ointments. When the opening is near the upper end of the intestine, the excoriation may prove a difficulty.

## SECTION VII.—SURGICAL AFFECTIONS OF THE LIVER AND PANCREAS.

### ABSCESS OF THE LIVER.

Abscess of the liver may arise from wounds and contusions, from exposure to cold, or from suppuration in connection with hydatid cysts; but in most instances, they are secondary to infection from the intestine, and occur chiefly in those who have lived in tropical climates and have suffered from dysentery. Sometimes they are multiple, scattered through the liver in all directions, as in fatal cases of pyæmia; more frequently, they are single or few in number, though they may have been formed by the gradual coalescence of numerous small foci, and then they may be very large, capable of holding four or five pints of fluid. The pus is usually dark chocolate in color, and sometimes fœtid. At first, the abscess may be deeply seated; as it enlarges, it approaches nearer the surface, until either it bursts into the pleura, peritoneum, or pericardium, or else, if this is prevented by the formation of adhesions, discharges itself externally, or into the bowel.

**Diagnosis.**—The diagnosis of deep-seated abscess in the early stage is exceedingly difficult. A history of residence in a hot climate, or of any rectal trouble, even years before; the occurrence of rigors, or of general feverishness, with pain and tenderness over the region of the liver; a muddy, perhaps jaundiced, complexion; irritability of the stomach, with vomiting and other signs of hepatic congestion, may excite suspicion, but no positive diagnosis can be made, without exploration by means of an aspirator. In the later stages, when there is a distinct enlargement of the liver, or when the skin over the surface of the abdomen is red and œdematous, this difficulty disappears; but the abscess must usually attain a very large size before it can produce such an effect.

Hydatids of the liver may be differentiated by the slowness of their growth, and by the absence of pain and fever; but this fails if the cyst is suppurating. A certain amount of difficulty may arise in the case of large single gummata of the liver, and of rapidly-growing tumors either of this organ or of the kidney. Pleurisy and pneumonia are not unfrequently present, especially when the abscess is situated near the posterior surface, and very great care may be required to make certain of the cause.

**Treatment.**—1. If the skin over the swelling is red, and pits on pressure, there can be little doubt either as to the existence of an abscess or the presence of adhesions. In such circumstances an aspirating needle may be used as a prelimi-

they may occur at any age, forming a tense elastic swelling which slowly extends in the direction of least resistance. Sometimes there is a smooth rounded prominence on the front wall of the abdomen, dull on percussion, and tense, without being tender. Occasionally fluctuation can be made out, or what is known as hydatid fremitus—a peculiar thrill only felt over cysts of considerable size. Often the cyst grows downward, simulating enlargement of the liver, and in a few cases it has reached so far as to be mistaken for hydronephrosis, and even for ovarian tumor. Not unfrequently serious consequences arise from pressure upon neighboring organs. Syncope has been known to occur; vomiting is not uncommon; respiration may be interfered with; or jaundice, ascites, or anasarca may follow.

Rupture of the cyst into the peritoneal cavity may occur, as the vascular adventitia is often defective on the serous surface, and is generally fatal at once. Communications occasionally form with the lung, so that the cysts are coughed up in numbers; but, as a rule, if the patient recovers, it is only after a long and severe illness. In a few cases the hydatids have been known to remain stationary for years and at length undergo degeneration and dry up into a calcareous mass; but suppuration with high fever and severe constitutional disturbance is more common.

The **diagnosis** rests mainly upon the age of the patient, the smooth, even shape of the swelling, and the absence of pain and feverishness. The chief difficulty arises with pleurisy, hydronephrosis, ovarian cysts and tumors of the liver; but as a rule exploratory puncture is conclusive. When suppuration has set in it is impossible to distinguish it from abscesses due to other causes.

**Treatment.**—There is no doubt that hydatid cysts are easily killed by withdrawing a small quantity of fluid from their interior, and when they are of moderate size and are deeply imbedded in a solid organ, there is a reasonable hope that if this can be done they may become calcified. In the case of larger ones, however, this is seldom satisfactory, partly owing to the risk of suppuration, partly to the impossibility of getting rid of the daughter cysts they so often contain. For these free incision is the only method.

As in the case of abscesses, this may be carried out in two steps, an incision being made down to the parietal peritoneum and plugged so as to procure adhesion between the opposing surfaces some few days before the cyst is opened; or, preferably, the whole operation may be completed at once. The surface of the liver where the cyst projects must be exposed by a free incision through the abdominal wall, the opening carefully packed with sponges, and then, while an assistant supports the liver by external pressure, a free incision is made into the sac and its contents evacuated. The side of the cyst is hooked up with the finger, the wall of the sac peeled off, disturbing the adventitia as little as possible, and the edge accurately sutured to the skin. In some cases the sac has been sponged out with iodine afterwards.

Tapping hydatid cysts with an aspirator is occasionally followed by urticaria, vomiting, and other symptoms of poisoning. I have known one instance in which sudden death occurred, and Bryant has recorded another; it may have been due to the sudden entry of some of the cyst fluid into one of the large branches of the hepatic vein, but more probably to shock.

## DISEASES OF THE GALL-BLADDER.

### *Biliary Calculi.*

Gall-stones are generally formed in the gall-bladder, although a few are met with in the hepatic duct, coming from the liver, and they may become impacted either in the neck of the gall-bladder, probably held by the peculiar folding of the mucous membrane, or in the hepatic, cystic, or common ducts. Sometimes they are single, or, at least, few in number, and of very large size; sometimes

they are multiple, occurring by the hundred, and having facets from mutual friction. Some are small, rough, and soft, composed chiefly of bile pigment, others formed of cholesterine are hard and brittle. They are most common in women, and after middle life, although instances of their occurrence in children are not unknown.

The symptoms to which they give rise are variable: it is not uncommon to find *post-mortem* that the gall-bladder is full of them, without there having been any reason to suspect their existence during life.

In some cases there are frequent and excessively painful attacks of biliary colic, with or without jaundice, according to the exact situation of the obstruction. The patient is never free from pain, there is a constant weight or dragging in the hepatic region, made worse by movement, and coming on with especial severity a few hours after food, causing vomiting and great prostration. This may end suddenly and finally with the passage of the calculus, or, on the other hand, the stone may drop back into the gall-bladder, and all the symptoms return again within a few hours.

If the calculus is impacted, the consequences are still more serious. When the obstruction is in the cystic duct, the gall-bladder only is involved, and it may either become immensely distended (dropsy), or inflamed and suppurate (empyema); when it is in the common duct, in addition to this, the liver is affected, jaundice sets in, and at length, unless some relief is given, cholæmia follows. Usually, this proves fatal within the twelvemonth.

[Occasionally the gall-stones dilate the gall-bladder so there is a distinct protrusion of the abdominal wall. The writer cut down upon such a swelling in the Saturday clinic at Rush Medical College in 1891, and removed twenty-seven small faceted gall-stones. These were contained in a pouch or diverticulum of the gall-bladder. A fistula persisted for some weeks after the operation, but finally healed after repeated injections of tincture of iodine.]

### *Dropsy of the Gall-Bladder.*

Distention of the gall-bladder is nearly always due to impacted calculus; in some rare instances other foreign substances, fragments of carcinoma, trematodes, etc., have been found instead, and occasionally it results from stricture, gummata, or peritoneal inflammation. The contents soon become altered in character; the bile becomes more watery; after a time it loses its color altogether, and at length it is replaced by a fluid that is either perfectly clear or is turbid from the amount of mucus it contains. The bladder itself swells up into a pear-shaped or semi-globular tumor which grows downward toward the umbilicus. Usually it is overlapped at its margin by intestine and there may be a clear note on percussion between it and the liver. The surface is smooth and uniform, firm and elastic to the touch, but sometimes very painful. The walls are nearly always thinned, and there is practically no limit to the size it may reach.

### *Empyema of the Gall-Bladder.*

Suppuration in the gall-bladder, which, according to Tait, is usual when only a few gall-stones are present, rarely leads to a tumor of such size. The walls are thickened in some parts and thinned in others, adhesions tying it down to all the structures near; the tissues become soft and easily torn, and, if the gall-bladder itself does not slough, the pus gradually works its way through the wall at some point or other. Sometimes it bursts into the peritoneum, causing fatal peritonitis; more often it discharges itself either into the stomach, duodenum, or colon; perhaps most frequently of all, adhesions form between the fundus and the abdominal parietes, and the abscess is either opened or breaks externally. If the obstruction is in the cystic duct this may give complete relief; if, however, the common duct is involved, a permanent biliary fistula is left, which usually proves fatal in the course of a year or two, from exhaustion.

**Diagnosis.**—Malignant disease of the liver, pancreas, pylorus, or of the gall-bladder itself, may cause a certain amount of difficulty. This is especially the case with the first mentioned, as biliary calculi are not unfrequently associated with carcinoma, though it is not easy to say in what relation they stand to each other. According to Tait, the presence of jaundice points distinctly to malignant disease, and, so far from rendering an operation advisable, suggests exactly the opposite conclusion, unless it is done merely as a temporary expedient for the removal of an obstructing calculus or the relief of biliary colic. Out of twenty cases operated on, carcinoma was present, or was very highly probable, in every one in which there was jaundice.

Tumors of the kidney, particularly hydronephrosis and floating kidney, have often been mistaken for distended gall-bladder, especially when there has been a history of the previous passage of gall-stones, and *vice versa*. The shape of the tumor and the relation that it bears to the bowel are the most important diagnostic points; but in many cases it is impossible to be certain without a preliminary exploratory incision.

Hydatid cysts, dermoid cysts, tumors in connection with the omentum, ovarian cysts, and other rarer forms of tumors, have occasionally given rise to difficulty. In any such case, a small exploratory operation is infinitely more safe and more certain than needling or aspiration.

## Operations Upon the Gall-Bladder.

According to Greig Smith, operation is required in all cases of empyema, dropsy, and persistently recurring colic. When jaundice is present, the prognosis is much more grave, not only for the reasons mentioned above, but because of the much greater risk of hemorrhage and the feeble power of repair. Still, it may be necessary to avoid the occurrence of cholæmia, and sometimes, even under these conditions, it is possible to effect a permanent cure—by crushing, for example, a calculus impacted in the common duct.

Aspiration through the abdominal wall cannot be recommended; it is not likely to effect a permanent cure, and it may lead to leakage through the puncture and peritonitis.

Free incision can only be practiced where there is an abscess pointing through the skin.

Incision into the gall-bladder after exposure through an opening in the abdominal parietes (*cholecystotomy*) is a most successful operation. A vertical incision is made over the most prominent part of the swelling, and the muscles and peritoneum divided in the ordinary way; the finger is then introduced to ascertain the condition of the gall-bladder, and, if it is much distended and not too much bound down by adhesions, a fine trocar and cannula is thrust into it to draw off some of the contents, and allow it to be pulled out through the wound, the greatest care being taken to allow none of the fluid to enter the peritoneal cavity. If catch or tooth forceps are used, they should be placed above and below the opening of the trocar, so that if the tissues, which are often very thin, are bruised, the injured part may lie in contact with the parietal peritoneum. As soon as the wall of the bladder is drawn out through the wound, a free incision is made into it, the rest of the contents allowed to escape, the interior carefully sponged out, and the finger introduced to ascertain if there is any obstruction present. Loose calculi present no difficulty, but if they are impacted far down in the neck, or in the cystic duct, the greatest care is required to avoid injury. Sometimes they may be removed by special forceps, the surface being gradually nibbled away, while the stone is fixed by the forefinger of the other hand pressing against it from outside the duct. On one or two occasions the stone has been broken by pressure from the outside, forceps guarded with rubber tips being used to avoid bruising as far as possible. Needling has been recommended to break them up. The mucous membrane has been very carefully nicked from the inside. The calculus has been left and the

fistulous opening syringed out constantly with warm water for a fortnight, and finally, when everything else has failed, the gall-bladder has been excised.

In a few cases the wound in the gall-bladder has been successfully sewn up and the emptied sac returned into the abdomen, but Tait, who has performed more of these operations and with better success than any one else, condemns this strongly. The walls are often exceedingly thin, it is very often impossible to make sure that the opening into the bowel is patent, and if any further operation is required it is decidedly advantageous to have the fundus of the gall-bladder adherent to the cicatrix. The walls of the sac, the parietal peritoneum, and the skin, should be accurately sewn together. Tait uses two continuous sutures, one for each side of the wound, the ends being tied together afterward, above and below. A large drainage tube is inserted, so as, if possible, to carry all the bile away from the wound, and ordinary absorbent dressings are applied. When the wound is healed the drainage tube may be withdrawn. If the obstruction has been removed the bile soon finds its way into the intestine again; if, on the other hand, this is impossible, a biliary fistula is left which may be dealt with later on.

*Cholecystectomy*, or removal of the whole gall-bladder, is a more serious operation, and should only be practiced when, from the condition of the parts at the time of the operation, it is clear that incision and drainage either are impracticable or would fail to give relief. Sometimes this occurs after prolonged inflammation; the gall-bladder is so utterly disorganized that it is not possible to suture it securely to the abdominal wound; and it may happen in cases of impacted calculus, if it is not possible to extract or crush the stone without injuring the wall of the duct. The preliminary steps are the same; the gall-bladder must be separated from adhesions, all hemorrhage carefully stopped, the peritoneal flaps united with a continuous suture, and the end of the cystic duct tied.

## Surgical Diseases of the Pancreas.

Large cysts, associated with obstruction of the main duct, are practically the only form of disease of the pancreas that comes within reach of the surgeon. They project forward, either beneath the right lobe of the liver or in the left hypochondrium, pushing the stomach to the right, the spleen to the left, and the transverse colon downward. In some cases fluctuation is very plain; in others there is communicated pulsation from the abdominal aorta, or the tumor moves up and down with respiration.

General emaciation is not uncommon; as it occurs even with small cysts it has been suggested that it may be due to interference with the solar plexus. There may be a sense of oppression or paroxysmal attacks of pain, deep between the ensiform cartilage and the navel, with a feeling of intense anxiety. Undigested muscular fibre may be present in the stools; vomiting is not unfrequent; the bowels are often very irregular, and sometimes at least the complexion becomes peculiarly earthy. The diagnosis can only be verified by aspiration. The fluid may be dark brown and turbid, like pea-soup, or the contents may be clear, or they may be mixed with pus or blood. In several cases the presence of similar ferments to those of the pancreatic juice has been ascertained by experiment. Hydatids of the liver and other organs, ovarian, mesenteric, omental, and renal cysts, dropsy of the omental bursa, and distention of the gall-bladder, closely resemble it, and, in many cases, have only been distinguished at the time of operation.

Extirpation may be practicable occasionally; in most instances, incision and drainage are to be preferred. The openings should be made over the most prominent portion of the tumor, the contents partially removed by aspiration, and the cyst drawn out and secured by sutures to the parietal peritoneum and the skin. If the discharge irritates the skin, boracic acid dressings should be used.

# CHAPTER XIX.

## *INJURIES AND DISEASES OF THE RECTUM.*

### Malformations of the Rectum and Anus.

Of these there are two chief varieties.

In the first the original cloacal outlet persists to a greater or less extent, and the bowel terminates in the bladder, vagina, or urethra.

In the second the communication with the genito-urinary organs is shut off, but the rectum does not open upon the surface; like the former, this is due to an arrest of development. The intestine is formed from the innermost of the germinal layers; at either end it terminates blindly, the anus as well as the mouth being developed by an invagination from the exterior. Consequently three degrees of defect are possible: the anus may be wanting, and the rectum well formed (the most common); the anus may be well formed and the rectum wanting (the most serious); or, finally, both may be present, but the septum between them persist, either as a definite membrane or as a mere epithelial layer.

Besides these, in exceptional cases, the orifice of the anus may be very small, and displaced, either forward, or to one side, apparently by a growth prolonged forward from the coccyx in the middle line of the perineum.

The **diagnosis** is usually apparent at once. If, however, a distinct anal diverticulum is present, the malformation of the rectum may be overlooked until suspicion is aroused by distention, persistent vomiting, and the absence of meconium. The condition, if unrelieved, is nearly always fatal within a few days; a few cases have lived for some time, even years, with regular fæcal vomiting. An exception may be made in the case of a vaginal opening, as this may not be discovered until adult life. If there is a communication with the urinary passages, death is usually caused by cystitis and pyelonephritis.

**Treatment.**—The child must be held in the lithotomy position (especial care is required to keep it straight), a catheter is passed into the bladder or vagina, according to the sex, and a thorough examination made.

In the slighter cases the bulging caused by the rectum when the child cries and the dark color of the meconium are visible at once, and all that is required is to tear through or divide a thin partition, leaving a little oiled lint in the opening as soon as the bowel has emptied itself.

In most, however, either from the anus being absent, or from the thickness of the tissues between it and the bowel, a median incision must be made through the skin from the site of the anus to the tip of the coccyx, and the dissection carried backward, guided by the catheter in front and the bone behind. If the bowel is near the surface it may be drawn down and sutured to the margin; but this is valueless if there is much tension. In this case a stricture is almost sure to follow unless special precautions are taken, a catheter or the tip of the finger being introduced at first every day. After a time the tendency to contract appears to diminish.

If the rectum is not exposed in this way, firm pressure should be made upon the abdomen, while the finger is in the perineal wound; sometimes the end can be felt, or the bulging is so plain that there is reason to believe it is not far off, and then the dissection may be continued along the sacrum until the peritoneum is reached, the coccyx being resected if necessary. When this does not succeed, the choice lies between inguinal and lumbar colotomy, preference being generally given to the former, not only on account of the more convenient situation of the anus, but because when the lower part of the rectum is not developed, the rest of the large intestine is very likely to be displaced and inaccessible from behind.

Opening the peritoneal cavity through the perineum has been advocated, on the ground that it saves the risk of a double operation, and that as the external sphincter is usually present in these cases, the inconvenience of incontinence would be avoided; but the difficulty of recognizing the character of the intestine at such a depth is very great, and the power of selection very small.

When there is a communication with the vagina a bent probe may be passed through it into the rectum as a guide; but it rarely happens that the opening is on the side of the bowel, with a blind pouch running beyond; nearly always it lies at the end. In this case, and also when the rectum communicates with the urinary passages, an anus must be formed, if possible in the natural situation, and the communication closed by a subsequent operation.

### Examination of the Rectum.

In many cases it is advisable to give an injection beforehand, so as to bring down the upper part of the bowel. The patient should lie well over on the left side with the hips and knees flexed, and the back to the light. The character of the skin and of the orifice of the anus is noted first, whether there is any discoloration, swelling, or abnormal opening. Then gentle pressure is made all round to ascertain if there is any induration or fluctuation, or any very tender spot, especially near the margin.

The mucous surface of the orifice is then inspected. The fingers are placed upon the buttocks, and, with the thumbs quite close to the anus, the sides are firmly separated while the patient strains down. Small ulcers and fissures at the margin, polypi, and internal piles can often be seen at once.

The finger is then introduced, well oiled, and the angles of the nail filled in with soap. The pulp should be placed over the orifice and the patient told to bear down; as the muscles relax they carry it in with them. If there is any evidence of fissure slight pressure should be made toward the opposite margin.

Except in the case of polypi, the marginal part of the mucous membrane is always examined first; painful ulcers, the orifices of fistulæ, and the like, are in the majority of instances within an inch of the edge. Then the investigation is carried higher, the character of the surface ascertained, and, by deeper pressure, the condition of the neighboring organs. By making the patient bear down, especially if he is standing, an inch or more of the rectum can be brought down on to the fingers; but in cases in which the disease is situated high up, or there is a difficulty of diagnosis, it is advisable to give an anæsthetic. When the muscles of the floor of the pelvis are well relaxed, the perineum can be pushed in in front of the knuckles, and the finger can generally reach the promontory of the sacrum. If this fail, further examination may be carried out with the speculum, the long tube, or the hand.

The most convenient form of speculum is a short conical metal tube, open at the end and on one side; but this, of course, only exposes the part immediately inside the anus. If it is wished to inspect the deeper portion the patient must be placed under an anæsthetic, in the lithotomy position, with the pelvis well raised so that the intestines may sink toward the diaphragm, and the sphincter be dilated. Metal tubes, then, of various sizes, may be very carefully introduced, the mucous membrane being lifted from off the opening from time to time with a sponge on a holder.

Rectal bougies as a means for diagnosis are dangerous and misleading. They nearly always catch, either against the sacrum or behind some fold of mucous membrane, and very often give rise to the suspicion of a stricture where none exists. Enema tubes are a little better, as by injecting fluid through them the mucous membrane may be lifted off from the end out of the way. Sometimes then the tube can be passed a few inches further, proving that there is no stricture; but, if it cannot, no conclusion can be drawn.

Finally, the hand, provided it is under seven inches in circumference, can be

introduced in most well-formed adults. The patient must be under an anæsthetic; the sphincter very gradually dilated; and then the fingers slowly wormed in with a screwing action until the broader part slips inside. Oil or vaseline should be freely used. I have on several occasions done this myself, and have found it once or twice of very great use in diagnosis. The proceeding is not without danger; there are several cases on record in which sudden death occurred, probably from rupture of the peritoneal band that surrounds the bowel. This can be felt like a cord passing across it obliquely, about four inches up, and it must on no account

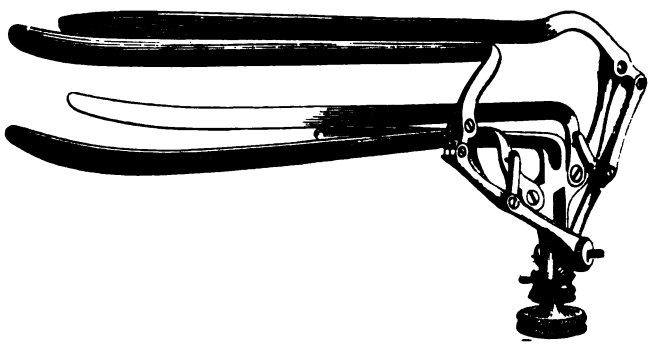


FIG. 410.—Allingham's Rectal Speculum.

be forced. The sphincter, of course, loses its power for some days, but I have never found any permanent paralysis follow.

If the hand cannot be introduced, owing to the peritoneal fold, a combination of these two methods is very useful, the long enema tube being passed up the palmar surface, and guided by the fingers into the smooth tubular portion above.

## INJURIES OF THE RECTUM.

Lacerations of the margins of the anus are occasionally caused by the passage of hardened fæces, or by the rough use of enema tubes, and sometimes they degenerate into very painful ulcers. The anus, too, may be torn in parturition, the perineum giving way completely.

Foreign bodies of all sorts occur from time to time, some, such as fish bones, enteroliths, gall-stones, and other foreign bodies, coming down from the bowel, others introduced from below; and it may require very great ingenuity to extract them without inflicting serious injury.

## HEMORRHOIDS.

The veins that surround the lower part of the rectum are exceedingly liable to become distended and varicose. Sometimes they remain in this condition; more frequently, owing to the congestion and œdema, and from the constant irritation to which they are subjected, the cellular tissue around becomes inflamed; the lymph that is poured out becomes organized, and at length distinct tumors, known as hemorrhoids, are formed. These may be classed as external, internal, or intermediate, according to their situation under the skin, under the mucous membrane, or partly under the one, partly under the other.

Their frequency is due to the structure of the part. The hemorrhoidal plexus lies under the mucous membrane, inside the margin of the anus, and a short distance up the bowel. The blood from this returns partly by the superior hemorrhoidal veins, which commence close to the edge, and run up in the sub-mucous layer before piercing the muscular coat; partly by the middle and inferior ones,

which end at length in the internal iliac. Of these the first are by far the most important; the others merely drain the anal margin and the region of the external sphincter; and the communication between the two is so poorly developed that it is of little use in affording relief; an injection thrown into the hemorrhoidal plexus through the inferior mesenteric does not pass on into the iliac veins. This plexus, therefore, lies at the root of the valveless portal system, and feels the strain first and most severely when anything impedes the flow of blood upward through the abdomen and liver.

Another point is that while the veins of the rest of the abdomen are supported by the walls, and prevented from becoming distended when the muscles of the abdomen contract, the hemorrhoidal plexus is entirely unprotected, and, owing to the peculiar laxity of the tissue in which it lies, is quite incapable of resisting the increased blood-pressure. Straining or bearing down, if there is the least dilatation, makes the veins swell out at once, and the mucous membrane becomes purple. This, of course, subsides again as the muscles relax, but it can easily be understood how the frequent repetition slowly but surely makes the dilatation worse and worse.

Verneuil attributes much importance to the superior hemorrhoidal veins passing through valvular openings in the muscular wall of the bowel a short distance above the anus, believing that the contraction tends to constrict them and check the flow. If, however, this were the case, it would easily relieve them from the backward pressure of the blood higher up in the portal system.

The exciting causes are of the most varied description. Every impediment to the return of the blood helps: valvular disease of the heart; chronic bronchitis and emphysema; cirrhosis of the liver; abdominal tumors; pregnancy; accumulation of fæces; everything, in short, that directly or indirectly checks the return circulation.

Constant straining, whether arising from constipation or from causes connected with the urinary tract, calculus, stricture, or enlarged prostate, acts in the same way, perhaps more rapidly.

Active congestion, such as arises from the repeated use of unsuitable purgatives, over-indulgence in alcohol, sexual excesses, and, in women, from uterine or ovarian affections, often brings them on. Still more frequently it precipitates an acute attack, and is the immediate cause of the patient applying for relief.

Whether hereditary influence has any effect of itself, as distinct from that which is due to the same habits and the same mode of life, is very doubtful. Few people attain old age without some enlargement of the hemorrhoidal veins; this is the natural result of the anatomy of the part. In the majority of cases, unless there is some additional reason, causing hyperæmia for some considerable time, and leading either to inflammation or to chronic congestion and œdema, the consequences are not sufficiently serious to make them apply for relief.

External hemorrhoids differ from internal ones in so many respects that it is advisable to deal with them separately. There is rarely any difficulty in distinguishing one from the other. The former are covered with skin, and, unless there is a large thrombus in some superficial vein, are some shade of pink, according to the pigmentation present and the degree of inflammation. Moreover they cannot be returned into the bowel by pressure. The latter are covered with mucous membrane; their surface is soft and smooth, and their color bright red or purple. If they have been prolapsed for some time they become dry and rough; but they can always be returned as soon as the sphincter is relaxed.

Intermediate ones, partly subcutaneous, partly submucous, with the white line that marks the junction of the two surfaces passing over them, are very common. Clinically they resemble internal ones in most of their features.

### External Hemorrhoids.

These begin as dilated veins around the margin of the anus and form soft, livid swellings which disappear on pressure and grow firm and hard when the patient strains. As such they may last for an indefinite time without the least inconvenience. Sooner or later, however, chronic congestion and œdema set in; lymph is poured into the cellular tissue; the veins are obstructed; and then, as the exudation becomes organized, the skin grows out into thickened, irregular folds, which, when once developed, are permanent. These are sometimes called cutaneous piles.

When these are irritated or become inflamed, all the symptoms are aggravated. In some cases the central vein is plugged with a thrombus; and a hard and tender knot, dark purple in color, forms in the centre of the pile. In others the cellular tissue is chiefly concerned; the pile becomes many times its former size; and the skin over it grows tense and pale from the amount of fluid it contains. Very often, just inside the anus, at the base of the pile, there is a small crack or abrasion from which the inflammation starts. In severe cases the whole circumference is involved, so that the opening seems buried in the centre of a swollen ring. When the vein is primarily affected the pile is sometimes called *thrombotic;* when it is chiefly the skin and cellular tissue, *œdematous;* but in many instances it is impossible to distinguish them.

**Symptoms.**—In the slighter cases there is merely a sense of heat and irritation about the anus, with itching, especially at night. Defecation is attended with a certain amount of pain, and there is rather a tendency to strain; but, so long as the bowels are moderately relaxed, there is little more than discomfort in the intervals between the motions. When the inflammation is severe, the pain may be intense, especially if the part is touched, and when the bowels are acting; in some cases it is almost as bad as in fissure, though it rarely lasts so long. The throbbing is constant; there is a persistent sense of fullness; the sphincter is in a state of spasmodic contraction; and, if the bowels are confined, the straining and tenesmus scarcely cease. Sometimes the constitutional disturbance is very severe, and in nervous, excitable people, there may be a high degree of fever. Suppuration is not uncommon, and though the abscesses are superficial, and break soon, they may leave troublesome fistula behind them.

**Treatment.**—If the case is seen before the inflammation is severe, the symptoms are easily relieved. The patient must remain quiet, as much as possible in the recumbent position; walking is painful and very injurious; the diet must be restricted; no stimulants or highly seasoned food allowed; and the bowels kept open with sulphate of magnesia or some appropriate mineral water. Small doses of calomel, or of podophyllin with taraxacum, may be given with advantage. A warm bath should be taken night and morning, and the skin around the anus should be kept supple with a mild astringent ointment, of calomel, lead, or nitrate of mercury.

When there is evidence of thrombosis or of suppuration more active treatment is required. If there is a small, hard lump, like a foreign body, in the centre of the pile, it should be transfixed, the clot turned out, and the vein allowed to bleed. Afterward it may be left to granulate. Large œdematous piles usually shrink of themselves as soon as the fissure or excoriation on which they depend is healed. Afterward, if thickened folds of skin are left around the anus, they may be removed with scissors curved upon the flat; but care should be taken not to cut them off at the base, for fear, when the wound heals, that the contraction may cause a stricture.

### Internal Hemorrhoids.

Of these there are two chief varieties—the sessile or capillary, and the venous or pedunculated. Not unfrequently they occur together, and probably they are

really due to the same cause; but there is sufficient difference in their symptoms and treatment to warrant a separate description.

### 1. *Capillary Hemorrhoids.*

These scarcely project above the surface; they are never extruded from the anus unless dragged down by pedunculated ones; and the veins are not much dilated. The capillaries and minute blood-vessels are chiefly involved; the submucous tissue is a little thickened; the epithelium is thinned and detached in places; while the mucous membrane is converted into a soft, spongy network of dilated vessels, so that it stands out from the smooth, even surface around like a bright red patch of florid granulations, which bleed at the slightest touch. It has been compared in appearance to a raspberry.

### 2. *Venous Hemorrhoids.*

These, like external ones, are at the first merely varicose veins. If the finger is introduced into the rectum, all that can be felt is a soft, smooth swelling under the mucous membrane, which disappears with the least pressure, and grows rather more firm when the patient strains. In many cases it is more easy to see than to feel them; if the rectum is washed out with a warm injection and the patient is directed to strain, as the mucous membrane becomes everted, the veins gradually swell up and stand out like lobulated bluish masses. After a time, if the congestion continues and becomes chronic, the tissue around them becomes thickened; they grow firmer and more solid; a sense of resistance is experienced by the finger; they stand distinctly above the surface, and no longer disappear when touched; and at length they develop into definite tumors.

As soon as this occurs, owing to the constant irritation to which they are exposed, the mucous membrane over them becomes thinned and ulcerated. Inflammation sets in; lymph is poured out; the neighboring blood-vessels, arteries as well as veins, dilate; and at length, as the exudation becomes organized, fibrous tumors are formed, springing from the submucous layer, filled with varicose veins, and not unfrequently containing arteries of considerable size, which they have dragged down with them. In many instances there are three or four of these, well inside the anus, some still sessile, others pedunculated, and hanging by stalks of various sizes.

The mucous membrane covering them does not long retain its smooth and soft appearance. Very often it becomes affected by the continued irritation; sometimes it is roughened and covered with florid granulations, as in capillary piles; more often it is thinned and ulcerated, so that the deeper tissues, perhaps the veins themselves, are exposed; here and there along the under surface it grows thick and dense. In older cases, in which the piles protrude from the anus, it becomes changed beyond recognition. Where they only descend at long intervals, and return easily of themselves, the surface may still be bright and smooth, though deeply congested; but if they protrude frequently it is sure to become inflamed and ulcerated, or converted by the continued friction into a dry, hard substance, almost like leather. When in this condition it is not always easy to distinguish it from skin.

Piles that protrude are always in danger of being caught and held, so that it is difficult to return them. The sphincter is in a state of painful spasm; the neck of the pile is tightly constricted; congestion and strangulation follow; and unless it is soon released the protruding part may become gangrenous. A large inflamed purple mass projects from the anus, surrounded by a broad band of everted muscle and mucous membrane. The skin all round is inflamed; the surface of the pile is greenish-black in color; the mucous membrane sloughs; and sometimes the whole mass perishes and is cast off. Occasionally a natural cure is effected in this way; much more often part only is lost, and the rest is retracted

**Symptoms.**—The only direct symptom of *sessile piles* is hemorrhage, but this may be so profuse and so constant, and recurring on every occasion when the bowels act, that the patient becomes absolutely blanched. There is no protrusion or pain unless the vascular patch is near the orifice.

In the *pedunculated* form bleeding is less constant and the amount more variable. At first there is merely a stain; later the blood may drip for a few minutes after every action of the bowels; occasionally it is profuse and comes in jets through a small opening in the wall of a vein, the spasmodic contraction of the muscles making it shoot out as if an artery had been divided.

At first the piles return into the bowel at once, either of themselves or when the patient lies down, with an immediate sense of relief. In a little while, however, it requires pressure to get them back; there is a deep throbbing pain, extending up the back and down the thighs; the sphincter is in a state of spasmodic contraction, the rectum feels as if it were distended to its utmost, and every attempt at procuring relief only makes the condition worse by the straining that accompanies it. Even when they are replaced it is some time before the patient is comfortable again. Sometimes, in these cases, they become strangulated and slough; the symptoms grow more and more severe; the parts around the anus are acutely inflamed, the inguinal glands enlarge, there is a very considerable degree of fever, and then, after the slough has separated, the inflammation gradually subsides. Sometimes, on the other hand, the sphincter loses its power and becomes relaxed; the severity of the symptoms diminishes, but the piles are constantly down. They descend on the least exertion, and at the most inconvenient times; there is a constant and most annoying discharge of mucus; the skin around the anus becomes sore and covered with vegetations; the mucous membrane at length becomes prolapsed as well; and in cases of long standing, there may be total inability to retain loose dejecta, or flatus.

**Diagnosis.**—External piles present no difficulty; condylomata, vegetations, cancerous nodules, and other growths around the anus can be distinguished at once. Internal piles, at the first commencement, when there is nothing but a varicose condition of the veins, may escape notice unless digital examination is carefully conducted; the soft loose folds of mucous membrane are emptied with the least pressure and disappear; but if the patient is desired to strain, or if the mucous membrane is gently everted after a warm injection, there can be no mistake. Later, when they protrude, it is sometimes difficult to distinguish them from prolapse of the mucous membrane, with which they are often associated; in the one, however, the protrusion is irregular in shape, and covered over with bosses; in the other it is smooth and uniform.

In all cases of hemorrhoids, external as well as internal, it is very essential that a thorough examination should be made, not only of the rectum, but also of the neighboring organs; otherwise the cause may be overlooked while a symptom is being treated.

**Treatment.**—1. *Palliative.*—In the early stage this may be efficient of itself; in the later, and after operations, it is no less essential to prevent piles already present becoming worse and others forming.

Diet demands the greatest care. Meals should be as sparing as consistent with health; all highly seasoned dishes, and alcohol, especially beer and heavy wines, strictly prohibited, and the allowance of meat limited. A fair amount of exercise must be taken, but long railway journeys should be avoided. The bowels must be made to act regularly every day, and the motions kept as soft as possible. Confection of senna, saline water, compound liquorice powder, or other laxatives may be taken the first thing in the morning. After each motion the rectum should be washed out with cold water, or with a weak astringent, to constrict the walls of the vessels. If the piles protrude they may be smeared over with an ointment of sulphate of iron or some other mild astringent before returning them. If they do not, a similar preparation, or the ointment of galls and opium, may be introduced either as a suppository, or with one of the special instruments devised for the

purpose. Bleeding, when it comes from a capillary pile, may be checked in the same way; but if it persist a more efficient application is desirable. In all cases careful inquiry should be made that there is no latent cause at work, especially connected with the urinary organs in men, and the uterus and ovaries in women.

2. *Radical.*—If the hemorrhage persists or is severe, even for a short time; if the piles are large and fibrous, so that they form distinct and solid tumors, or if they are constantly descending, or constantly giving rise to pain and inflammation, something further is required.

Inflamed and prolapsed piles may be returned and the sphincter dilated, operation being postponed until the sloughs have separated; but in most cases there is no reason why they should not be dealt with at once.

Operations should not be performed during pregnancy or shortly after parturition, an exception being made in the event of hemorrhage; nor should anything be done if there is a definite local cause, such as displacement of the uterus, stricture of the rectum, carcinoma, enlargement of the prostate, or other affections of the urinary organs. These must first be relieved; then, if the piles persist, something may be done for them; otherwise healing is delayed, and rapid recurrence is sure to take place.

A great variety of operations have been devised for internal hemorrhoids; some of them have been "invented" over and over again, but many are only used in special cases. For all alike the patient requires preparation. The large intestine must be emptied, and the bowels made to act freely before the operation. As a rule, it is sufficient to give a dose of castor oil the night before, and an injection the morning of the operation; but if the patient has been living freely, and the liver is congested, small doses of calomel or blue pill, followed up with some aperient mineral water in the morning, may be given for several days previously. An anæsthetic is necessary in all but the most trivial cases (in which cocaine suffices) and where carbolic acid is injected. Generally, it must be given freely, as the anus retains its sensitiveness longer than almost any other part of the body.

For all but Whitehead's operation, for which the lithotomy position is preferable, the patient should lie upon his side, with the back to the light and the knees well drawn up; and the table should be of a convenient height. The upper buttock is raised by an assistant, who also prevents the legs being straightened out.

### 1. *Dilatation.*

Simple dilatation may prove an effectual cure when the piles are recent, especially if there is much spasm or hypertrophy of the sphincter, such as is often combined with ulcer or fissure of the rectum. In other cases, in which a more serious measure is inadvisable, it often gives great relief; and (unless the muscles are relaxed already) it is always a most useful addition to ligature and other operations, preventing spasmodic contraction afterward. No instrument is required. The thumbs are inserted into the rectum, taking care to introduce them sufficiently far to catch the whole of the sphincter; and the anus gently dilated, first in one direction, then in another, until the contraction is thoroughly overcome and the muscle feels soft and pulpy. The skin is not torn, but bruising is generally apparent afterward. The patient should be kept in bed for two or three days, on light diet, and if there is much soreness about the part a morphia suppository may be given; but care must be taken that the bowels are not confined. At the end of that time he may be allowed to sit up, and it will be found that the veins have relieved themselves and to a great extent recovered their tone. It must not be forgotten, however, that, if the original causes are allowed to continue, and the bowels are not carefully attended to, the symptoms are sure to return.

### 2. *Injection of Carbolic Acid*

is of very limited application. Its chief merit is that it is not necessary to confine the patient to bed for more than one day; but it is very uncertain; it may produce

too great an effect or too little; and as it is necessary, if the piles are numerous, to repeat it again and again, the benefit is more than doubtful. Three or four drops of a strong solution of carbolic acid (gr. x, ad ʒij) (.60 ad 32 c.c.) are injected with a hypodermic needle into the centre of the pile, taking care not to allow any to come in contact with the surface. It swells up immediately and must be returned at once. There is little pain, and in many cases, as the inflammation subsides, the pile gradually shrivels up and disappears. I have tried it on several occasions, and no doubt it is effectual in the slighter cases, for a time at least; but it is not a radical operation in any sense of the term.

### 3. *Application of Acids.*

Sessile piles, when there is a bright granular patch of mucous membrane which bleeds at the least touch, may be cured in this way; for all other forms it is useless. Nitric acid or the acid nitrate of mercury is generally used; but chromic acid and strong carbolic acid have been recommended. The patient must be anæsthetized; the sphincter stretched and the patch well exposed with a speculum. The surface is then dried with cotton-wool, and the acid painted over it with a glass brush, taking care that none comes in contact with the skin or the margin of the anus. Any excess should be mopped up at once. A morphia suppository is introduced afterward to prevent pain and spasms, and the speculum withdrawn. A superficial slough usually comes away in the course of a few days without being noticed, and the granulating surface left contracts and obliterates the deeper part of the vessels.

### 4. *The Actual Cautery.*

This may be used in two ways. In one the pile is drawn down, seized with a clamp (the surface of which is faced with ivory or some other non-conducting substance), and tightly compressed. The projecting portion is then cut off; the clamp unscrewed, and each point as it bleeds touched with the cautery at a dull red heat. As soon as the whole surface is seared the clamp is removed and the

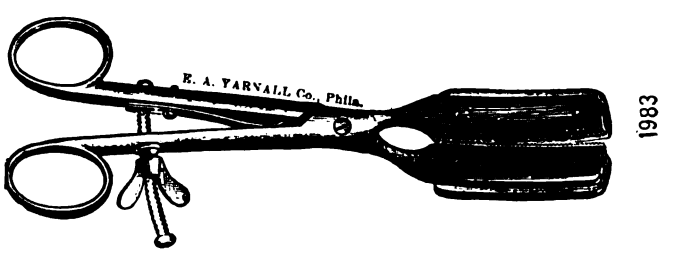



FIG. 411.—Clamp with Parallel Blades for use with the Cautery.

process repeated upon another. This has been strongly recommended, but it is more liable to secondary hemorrhage than a ligature properly applied; and it is not easy to control the extent of mucous membrane that is destroyed. The cicatrices left by burns are notoriously prone to contract and become rough and irregular afterward. In the intermediate form of pile it certainly should not be used, as the actual cautery applied to the skin is excessively painful.

In the other method a pointed iron or platinum cautery (Paquelin's is the most convenient), at a white heat, is thrust quickly into the centre of a pile, allowed to remain a second or two, and then withdrawn. There is no hemorrhage and very little inflammation. This method is scarcely applicable to piles of any size, but where one or two small outlying ones are left after ligature, and it is not considered advisable to take up any more mucous membrane, it answers very well.

### 5. *Crushing.*

In this the base of the pile is seized in a clamp, the edges of which are beveled to prevent cutting through, and crushed by means of a screw. The anus must be dilated first; the pile drawn down, and the instrument applied so as to

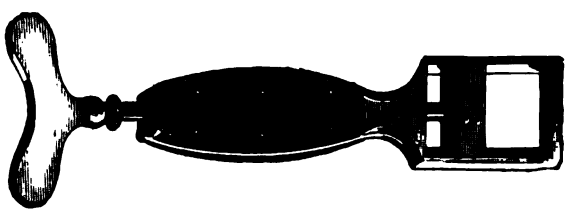


FIG. 412.—Screw Clamp for Crushing Piles.

avoid injuring the skin. The projecting part is cut off, and the clamp unscrewed, after keeping up the pressure for at least two minutes. For small detached piles there is no doubt this method is valuable. If the pressure is maintained for a sufficient time there is little risk of hemorrhage: the wounds heal more quickly than after ligature; and in most cases the pain, when the bowels act for the first time, is less; but, especially in the case of broad-based vascular piles, care is required to prevent the mucous membrane being too much involved.

### 6. *Ligature.*

For all ordinary cases, ligature is safe and effectual; it may be applied to every form of pedunculated pile, though, as already mentioned, one or two varieties are capable of being treated at least as well as in other ways.

The sphincter is dilated; the most prominent pile seized and drawn down with vulsellum forceps, and an incision made three-quarters around its base with a pair of sharp, spring scissors. The portion left is the mucous membrane that comes down from the bowel on to its upper surface; if there are any large vessels, especially arteries, in the pile, when it is drawn down in this way, they lie close beneath. The cut, therefore, runs along the white line between the skin and the mucous membrane, or just above this, and up each side of the base, parallel to the bowel. A well-waxed piece of whipcord is now placed at the bottom of this groove and tied high up, as tightly as possible. The first knot should be a double one, to prevent slipping.

Two, or perhaps three sets of piles may require tying in this way. If they are very large, the strangulated part may be cut off, but care must be taken to leave enough to prevent the ligature slipping. Any external or intermediate piles left should be dealt with at the same time, or they are very liable to swell up and become inflamed. Finally, a morphia suppository is introduced to prevent straining, and a T bandage with a firm pad placed over the anus. The patient should be kept in bed for at least a week, on light diet, and the bowels prevented from acting for four or five days; at the end of that time, if they do not move of themselves, a full dose of castor oil may be given, or a compound colocynth pill, followed next morning by an aperient draught. The first action of the bowels is always painful, and it is essential to avoid straining. The ligatures usually separate and come away about the fifth day, leaving comparatively small granulating surfaces.

[Ligatures are also introduced by transfixion with an ordinary transfixion needle. The pile is first drawn out with a tenaculum; the needle passed through the pile at its base; a stout, silk ligature is threaded in the eye of the needle, which is then withdrawn, carrying with it the doubled ligature. The ligature is then cut, and the ends tied at the base of the pile.]

If all goes well, the patient may be allowed to lie upon a sofa at the end of a week or ten days. The anus should be sponged with warm water and some mild antiseptic every night and morning; or, as soon as the patient can sit up, a warm hip-bath may be taken once a day. If there is much inflammation about the part, a pad wet with lead lotion may be kept upon it; or, if this fails, hot fomentations may be tried. The wounds generally heal readily, but the recumbent position is essential. A mild astringent ointment may sometimes be introduced into the rectum with advantage, after the ligatures have separated.

### 7. *Excision (Whitehead's Operation).*

The anus is dilated; an incision is made through the mucous membrane just inside the orifice all the way round; the sphincter is exposed; and the mucous membrane, with the attached hemorrhoids, is stripped from the muscles beneath, until the whole pile-bearing area is detached, and can be brought outside. This dissection (except above and below) may be readily managed with the closed scissors, without any serious hemorrhage, The upper part should, of course, be left to the last. As soon as this is thoroughly separated, the lower end of the projecting tube, with the hemorrhoids attached to it, is cut off transversely, bit by bit (the arteries being tied or twisted as they are divided), and fastened with sutures accurately to the divided edge just inside the anus. Union ought to take place by the first intention.

Where there is a ring of veins forming a varicose plexus all round the inner margin of the anus, this method is most effectual, and it possesses the merit of being thorough. It is not probable, however, that the percentage of relapses after ligature, if the operation is properly performed, is very much higher; the cicatrization that follows tends, in a marked degree, to constrict the rest of the blood-vessels and support the mucous membrane, and there is no comparison as to the relative facility of the two proceedings. Whitehead's may secure union by the first intention; but, if this fail, and the mucous membrane retracts, a granulating sore is left, extending all round the bowel, and this is not unlikely to leave some constriction behind it, though it is only fair to say this never occurred in Whitehead's practice.

### *Complications after Operation.*

Retention of urine is exceedingly common. In a few instances, it can be relieved by loosening the bandage and applying warm fomentations to the pubic region; but, as a rule, it requires a catheter, and sometimes this continues necessary for ten days or a fortnight.

Recurrent or secondary hemorrhage may be very serious. A little oozing is not uncommon a few hours after the operation, and again when the ligatures separate; but sometimes a large vessel gives way, or the tissues are so soft and vascular that blood seems to pour out from the whole surface. There may be no external sign for a long time; the patient complains of feeling faint and of a desire to go to the closet; there is a moment's straining, and an immense quantity of blood-clot is suddenly poured out. Slight hemorrhage may be checked by pressing small lumps of ice in the rectum, or by washing it out with ice-cold water. If, however, there is any considerable loss, the patient must be placed under an anæsthetic, and the bowel thoroughly explored, the mucous membrane being pulled down bit by bit, through the dilated anus. Sometimes the bleeding point can be seized with pressure forceps, or it is possible to apply a ligature; if, however, either it cannot be found, or the tissues are too soft to hold, the only means of arresting the hemorrhage is to plug the rectum. This is best done with a tampon, similar to that used after lithotomy, only much longer. There should be a central tube, through which flatus and liquid fæces can escape. A convenient soft, distensible rubber-bag, which can be dilated to almost any size with air or water. If this is not at hand, a conical sponge, with a string

If this fail nitric acid may be tried; an anæsthetic must be given, the
fistulous tract dried, and brushed over with strong acid, care being taken that none
is in contact with the skin. Then the part must be returned, a small piece of
wood being left in the rectum, and a large pad placed over the anus and kept
firmly in position with strapping. The bowels must be kept confined for
five days, the patient being in bed, and when they are allowed to act
a mutton must be taken to keep the motions soft and to prevent the straining
so, again.

If hæmorrhoids are present they should be removed at a subsequent
operation, but if the mucous membrane and the sphincter of the
anus, however, the whole of the prolapse

the peritoneum; if it is too large the opposing surfaces are carefully sutured ther before anything further is done. As soon as this is secure the inner tube pened by a transverse incision corresponding in length to the size of the peri- al pouch, and the cut edges of the muscular and mucous coats of the two tubes arately fastened with a double row of sutures. The posterior half of the umference is then divided, and sutured in the same manner, and the whole lapsed portion detached. The vessels, which are often numerous and of con- rable size, lie for the most part in the posterior half.

A similar operation has been performed in intussusception when the invagi- ed part protrudes from the anus.

## Polypus of the Rectum.

The term polypus has been erroneously applied to almost any outgrowth from mucous membrane that projects into the cavity of the bowel. A polypus uld be pedunculated, but it may be sessile, provided the base is relatively small; it may be a new growth altogether—adenoma or fibroma—or a mere over- wth of the normal tissue of the part. Generally polypi are single, growing in a short distance of the anus, from the dorsal surface of the bowel; but etimes there are two or three, and in a few instances there have been hundreds. rule, their size is not great; the fibrous ones are seldom larger than a walnut, adenomata in most instances are not so large; but when there are two or e together, they have been known to block up the interior, and give rise to ptoms of obstruction.

The soft polypus is most frequent in children. It is generally the size of a berry, bright red in color, smooth or slightly granular on the surface, and ds at the least touch. It is composed mainly of tubules lined with columnar helium, like Lieberkühn's follicles, held together with a delicate connective ue, and dilated in places into cysts; sometimes there is a little more fibrous ue, and occasionally a few unstriped muscular fibres. At first they are sessile, as they rarely give rise to symptoms until they protrude from the anus, a long slender pedicle is generally present by the time the diagnosis is made.

Fibrous polypi, on the other hand, are rare except in adults. They spring rently from the submucous layer, and are composed of fibrous tissue, which be so hard as to creak when divided with a knife. It has been suggested they are really adenoid polypi, which in course of time have become hardened condensed by constant irritation. Occasionally it is almost impossible to dis- uish them from internal hemorrhoids.

Besides these, polypoid outgrowths of mucous membrane, hypertrophied from istent irritation, are often present in cases of fissure just inside the anus.

**Symptoms.**—These are not definite until the pedicle is long enough to be ped by the bowel. In children, bleeding from the anus is often the first thing iced, and in the absence of injury may be regarded as almost conclusive. metimes the growth is extruded during defecation, and is caught by the sphinc- giving rise to pain and spasm; and it may even slough off, and undergo ntaneous cure. In adults hemorrhage is not so conspicuous, but there is usually considerable discharge of mucus, like thin starch or white of egg, not only h the motions, but in the intervals. If the polypus comes down, the pain and itation may be very severe, and it may drag the bowel down with it so as to se prolapse, or, if it is situated higher up, intussusception.

A protruding polypus can be recognized at once by its appearance. If it is visible at first, an injection may be given, and the part examined immediately r. When the finger is introduced it is advisable to pass it up to its full length nce, and search the mucous membrane as it is withdrawn; otherwise a polypus h a slender pedicle may be pushed up in front of it and missed.

**Treatment.**—Polypi may be removed by torsion and ligature. The former wers very well in children, and if the pedicle is really twisted off, is not fol-

lowed by hemorrhage; the latter is better if the pedicle is of any size, and for fibrous growths. An anæsthetic is advisable, and advantage should be taken of the opportunity to make sure that only one is present. If a ligature is used, the same precautions should be adopted as after operations on hemorrhoids, for fear of ulceration.

### Pruritus.

Many affections of the anus and lower part of the rectum are attended by a sense of itching, which may become so intolerable as to render the patient's life utterly wretched. It usually begins at night, as the body is getting warm in bed, and it may entirely prevent sleep; in the worst cases it lasts more or less all day, and the least friction brings it on. Scratching makes it tenfold worse.

The skin around the anus in an old case is thickened, hardened, excoriated, and often eczematous, from the constant irritation. Sometimes nothing else can be found; the original cause may have disappeared, the complaint being kept up afterwards by this alone; more often there is some affection of the rectum—hemorrhoids, prolapse, stricture, or a profuse mucous secretion that keeps the part continually moist. Venous congestion is the exciting cause in most cases; it is very common in connection with gout; many people only suffer from it when the liver is congested or the bowels constipated; in others an attack is always brought on by certain articles of diet, especially alcohol and highly seasoned food; in women it may be due to uterine disease, and in a few cases it seems to be associated with mental worry. Sometimes it is a pure neurosis, occurring whenever the patient is out of health; as a rule, however, some definite exciting cause can be found.

**Treatment.**—The first thing to do is to remove every local affection that can act as a cause. If, however, the complaint has lasted any time and the skin is altered in texture, it may be very obstinate. The bowels must be made to act regularly; the diet must be restricted, especially in the direction of beer and spirits; small doses of calomel or of podophyllin given from time to time, and if there is any suspicion of gout, lithia or potash, with sufficient fluid. A fair amount of exercise should be taken, and the part should be sponged well night and morning, and after each action of the bowels. A lotion of milk and acetate of lead may be used afterward, or the glycerole of starch and borax. Cocaine always gives temporary relief, and is especially useful at night, securing some chance of sleep.* If the skin is reddened and excoriated from constant scratching, mild astringent ointments are sometimes beneficial. In other cases, in which it is thick and hard, a strong solution of nitrate of silver or of acetic acid may be applied to the surface, taking care that none comes into contact with the anal margin. The patient must be kept in the recumbent position until the epidermis is restored again.

Dilatation of the sphincter succeeds sometimes after everything else has failed, especially if the spasm is severe. Allingham mentions that in one instance relief was obtained by the patient wearing a bone plug in the anus at night.

### Proctitis.

*Catarrhal inflammation* of the mucous membrane may arise from various causes: gonorrhœal infection, especially in women; syphilis during the secondary stage; abuse of purgatives; gout; errors in diet, etc. Except when it is due to the first of these, it is rarely severe; there is a sense of heat and weight in the perineum, with a constant desire to defecate. The sphincter is in a state of painful spasm; the anus is hot and tender; the amount of mucus is increased;

* [Sponging with hot water is equally effective. In severe cases the sponge may be allowed to remain against the itching part until the patient sleeps. Hot mercuric or carbolic solution is preferable to plain water in these cases, for obvious reasons.]

and this escaping externally leads to excoriation and perhaps superficial ulceration. As a rule the symptoms subside as the cause is removed; sometimes, however, they become chronic; and occasionally, when severe, painful catarrhal ulcers develop, require special treatment.

*Ulceration* of the rectum is much more serious, not only for itself, but from the way in which it leads to stricture and fistula. In some cases it is the result of injury, the introduction of foreign bodies, the use of enema tubes or the passage of hard scybalous masses, especially as the circulation is often sluggish and the tissues badly nourished, from the presence of varicose veins. In others it arises directly from thrombosis and inflammation of the veins; or from dysentery involving the rectum as well as colon. When this occurs the ulcers it leaves are of a peculiarly irregular character; they spread in all directions, forming little islands which, as cicatrization takes place, stand out as hard warty excrescences; or they undermine the mucous membrane, so that it leaves rigid cords passing across the interior from one part to another; and the scars are of such extreme density that not improbably many of them have been mistaken for scirrhus.

In other cases ulceration is due to syphilis. In its earlier stages this attacks the anus chiefly; condylomata and superficial sores occur round the margin, leaving irregular folds of skin with painful fissures in between, not unlike those at the angles of the mouth and nose. In the latter it breaks out on the mucous membrane, some distance from the anus, forming deep serpiginous sores, which may extend almost round the bowel.

Tubercle is still more common, beginning in the adenoid tissue between and beneath the follicular glands. Little nodules make their appearance first, not larger than millet seeds, and only slightly raised above the surface; after a time these become caseous and break down, leaving shallow depressions, which grow larger and deeper, until at length they become circular sores with overhanging edges. In other cases, the caseous deposit seems to infiltrate the adenoid tissue in the mucous and submucous layers before the surface gives way, and deep, irregular ulcers are formed, which almost at once become the orifices of tuberculous fistulæ.

Ulceration somewhat similar in character is not unfrequently associated with albuminuria; probably it originates as catarrhal inflammation; after a time the lymphatic follicles become affected, and break down; and then, as there is no longer any protection against septic infection, the deeper tissues become inflamed as well. In many cases it is difficult to distinguish this from the preceding; they both occur in patients whose health is broken down, and whose tissues are badly nourished; and they both lead to ulceration, and not unfrequently to fistulous channels of very much the same description.

In addition to these, lupoid ulceration may attack the skin around the anus and the mucous membrane of the rectum. It is essentially destructive in character and cicatrization is unusual. The edges and base are not hard, as in malignant disease; and the former are undermined and overhanging. Sometimes it remains stationary for a time, and is apparently beginning to heal; then it all breaks down again. It is only met with in tuberculous subjects, and probably is itself tuberculous. The only treatment that has proved of any use is scraping and the actual cautery; sometimes the pain, at least, can be relieved in this way for a time.

**Symptoms.**—In acute inflammation of the rectum the patient complains of a sense of heat and weight in the perineum, spreading over the back and thighs, and of violent straining and spasm of the sphincter. The skin is dry and feverish; the anus is very tender; the finger, if it is introduced, is tightly gripped; and the mucous membrane feels burning hot. In severe cases the constitutional symptoms are very marked; the pain radiates over the whole of the lower part of the body, and there is nearly always retention of urine.

The symptoms of ulceration depend upon its situation. When the anal margin is involved, they are so striking and so severe that this affection is described by itself as *fissure of the anus*; when, on the other hand, they are higher

up, above the level of the external sphincter, they are at first very vague. Diarrhœa is the most prominent; as soon as the patient gets out of bed there is an immediate desire to go to the closet, and a small quantity of liquid fæces with some mucus, like white of egg, comes away. The same thing occurs perhaps once or twice in the morning; and then, if the ulceration is not far advanced, the rest of the day is passed in comparative comfort; the rectum is empty and there is nothing to irritate it. In all but the slightest cases, however, there is a constant sense of fullness and tenesmus; normal motions are never passed; the amount of discharge increases; it loses its simple mucous character, and becomes dark, like coffee-grounds. Control over the sphincter is lost; the skin around the anus is constantly moist; it becomes covered with vegetations and excrescences, between which fissures form. Then the pain becomes more severe; after each motion it is intense, and in the intervals there is always a constant dull aching. Finally, the diarrhœa becomes almost continuous; health and strength fail; the appetite is lost; colicky spasms and pains over the lower part of the abdomen grow more frequent; abscesses and fistulæ form around the bowel; the emaciation becomes extreme; and the patient sinks from exhaustion, if he is not carried off by some intercurrent disorder.

**Diagnosis.**—In advanced cases the appearance of the anus at once suggests the presence of more serious mischief. The thickened and pigmented folds, with deep and painful ulcers in between, and the eczematous condition of the skin, can only be caused by long-continued irritation; but the diagnosis can only be made with the finger or the speculum. The former is nearly always sufficient; the latter can only be used with an anæsthetic, and with either the utmost gentleness is essential. Immediately inside the anus the mucous membrane is generally unaffected, though both in syphilis and advanced tubercular or lupoid disease it may be nearly as bad as the rest; higher up the normal soft character of the bowel is entirely lost. The surface is rough and irregular; hard nodules project here and there; in some places the walls are dense and thick, like stricture tissue, and the passage is narrowed; in others there are soft smooth patches, surrounded with overhanging edges, which bleed at the least touch; and the finger when it is withdrawn is smeared with blood-stained mucus.

Sometimes it is possible from this alone to form an opinion both as to the extent and cause of the disease. Syphilitic ulceration is often accompanied by other signs; tubercle rarely leads to the formation of dense cicatrices, and fistulæ generally make their appearance very soon. Dysentery, on the other hand, may destroy all trace of normal mucous membrane, and often extends far beyond the reach of the finger. In the majority, however, a careful inquiry into the history, and into the other symptoms that are present, is essential; and even then it is sometimes difficult to exclude the idea of malignant disease.

**Treatment.**—Rest is the first consideration. The patient must lie down for at least the greater part of the day, with the foot of the bed raised to prevent venous congestion. The fæces must be kept as soft and as small as possible; everything that is stimulating or indigestible, or likely to leave a bulky residue, must be strictly avoided. Pure milk diet for a time is often advantageous. All straining must be prevented; the bowel must be washed out night and morning with warm water or an astringent lotion—nitrate of silver in the case of dysentery, lotio nigra for syphilis; and after this a simple unirritating ointment (calomel, gr. x ad ℥j (.60 ad 32), nitrate of bismuth, iodoform, or nitrate of mercury), may be applied either as a suppository or with a suitable ointment introducer. Starch and opium injections are excellent means of controlling the diarrhœa.

In the meanwhile constitutional treatment must not be neglected. Iodide of potash must be given in syphilitic cases. Cod-liver oil, if the patient can take it, often answers better than anything, as there is nearly always great loss of flesh and strength, and it tends to keep the motions soft; if iron is given care must be taken that the bowels are not confined. In a few cases where the ulcer is low down, and the spasmodic contraction of the sphincter is severe, perfect rest may

be obtained by subcutaneous division of the muscle or by stretching it; but this is seldom of any good in the more severe forms. In these, when all local treatment fails, colotomy is the only resource.

## PERIPROCTITIS.

Inflammation around the rectum may occur at the anus, in the ischio-rectal fossa, or higher up in connection with the insertion of the levator ani and the recto-vesical fascia.

1. *Inflammation around the margin of the anus* in many cases is symptomatic of some deeper disorder: there is a constant offensive discharge from the anus; the parts are continually moist; the epidermis is macerated; and the deeper papillary layer of the skin exposed. Inflamed external hemorrhoids, small cutaneous boils, suppuration in connection with the hair follicles, and syphilitic eruptions are not uncommon. Very often it is due to injury, repeated straining, the passage of hardened fæces, or the abuse of enemata; or it may occur after parturition. Of itself it may be trivial in character, but it becomes of great importance from the tendency it has to leave behind it painful fissures and superficial fistulæ.

2. *Ischio-rectal abscess* is much more serious. It may be acute or chronic. In the former case the symptoms closely resemble those of proctitis. It may commence with a rigor; the pulse is quick, the tongue furred; there is the most intense throbbing in the perineum; sitting down is almost impossible; the rectum feels as if it were loaded with fæces, but the least attempt at relief brings on the most violent pain and straining. On examination there is a hard, brawny swelling by the side of the anus; the skin is red and œdematous, pitting on pressure; and if the finger is introduced into the bowel, the hardness can be felt through the wall for some distance above. Sometimes the inflammation is even more acute than this, and a form of gangrenous cellulitis which may prove fatal sets in.

In the chronic form, on the other hand, the swelling is painless, and often lasts for weeks. There is merely a soft fluctuating swelling, filling the whole of the ischio-rectal fossa and extending up by the side of the bowel, covered in with a thin layer of discolored skin. Not unfrequently the patient is almost unaware of its existence, and it may attain a very large size and burrow for a considerable distance before the skin gives way. When this happens, the opening is always large and ragged, with thin, overhanging edges, like those of a scrofulous sore, and a fistula is almost certain to be left.

The frequency with which these abscesses occur is accounted for partly by the ease with which septic absorption takes place through abrasions of the mucous surface, partly by the anatomy of the region. Owing to the rapid variations in size of the bowel, the tissues are badly supported; the circulation is feeble; there is a large amount of loose fat with dilated veins; and the vessels have even a greater tendency to become varicose than those of the lower extremities.

Phlegmonous inflammation is rare, except in those who are thoroughly broken down; most of the cases recorded have been in persons who were suffering from specific fevers. Acute abscess may usually be traced to exposure to cold; injury; perforation of the mucous membrane from the inside by a fish-bone or other foreign body; tearing of the mucous surface from straining or the passage of hardened fæces, or bruising of the subcutaneous tissue, leading to extravasation in the ischio-rectal fossa or venous thrombosis. The chronic form is probably due in a very large number of cases to the breaking down of tubercular deposit in connection with the adenoid tissue of the rectum; or it may be a complication of stricture, beginning either from an ulcer on the mucous surface, or independently of this in the lowly organized inflammatory exudation surrounding the bowel.

In addition to this, suppuration may extend into the ischio-rectal fossa from distant organs: urinary abscess is not uncommon; necrosis of the sacrum or

coccyx occasionally gives rise to it; coccygeal dermoid cysts may cause it; and it has been known in caries of the lumbar vertebræ.

Ischio-rectal abscesses should be opened at once and freely, or a fistula is almost certain to form. Even if there is merely a tense, hard, and painful swelling, it is better to run the risk of not finding pus. If the abscess is small and close to the rectum, so as to give rise to the suspicion that it is really intramural, the patient should be placed upon his side, with the knees drawn up, and the finger introduced into the bowel to fix the swelling and make it project toward the skin. Then a straight bistoury is introduced, and an incision sufficiently free to give exit to the pus, made radially from the anus. Some of the outer fibres of the external sphincter are divided, and the opening will not close too soon. True ischio-rectal abscesses, on the other hand, must be laid freely open by a longitudinal incision, parallel to the anus, midway between it and the ischium; and as soon as the pus has escaped, the finger must be introduced, the cavity explored, and the partitions inside broken down. Afterward the opening must be kept patent to ensure the abscess healing from the bottom. Lint should be avoided, as the discharge is liable to collect behind it, and its removal is very painful. Gutta-percha tissue, folded irregularly so as to fit inside the orifice without blocking it, is the most convenient. The cavity, if the dressing does not come away easily, can be syringed out behind it, and it does not absorb the discharge. The patient should be kept in bed, or at least lying down, until the abscess has healed. If it is an acute one, this will not be many days; if it is chronic, the greatest care is necessary to prevent it degenerating into a fistula. The bowels should be well opened once, and then kept confined for several days, the diet being very light, so that there may not be an accumulation of fæces. When they are opened an effectual purge should be given to avoid straining.

3. *Inflammation on the Visceral Surface of the Levator Ani.*—This is nearly always caused by extension from some of the neighboring viscera, and if it involves the rectum is nearly always associated with stricture. Occasionally it originates from the bowel, much more frequently from the uterus, following parturition or metritis, and probably it is for this reason that stricture of the rectum is so much more common in women than in men.

The inflammation may be acute, attended with high fever, and soon ending in suppuration; or chronic, spreading from one part to another until they are firmly bound down to each other and to the pelvis by bands of cicatricial tissue which may be almost of cartilaginous hardness. When it starts from the region of the uterus, the anterior surface of the rectum is first involved. The inflammatory exudation spreads into the substance of the muscles until the fibres become atrophied and the walls hard and unyielding; the mucous membrane becomes rigid and unable to unfold itself; the constant irritation caused by the passage of the fæces gradually leads to hyperæmia and thickening of the submucous tissue; and at length a definite stricture is formed, which may be either tubular in shape, extending for some distance along the bowel, especially on the anterior surface, or sharp, well-defined, and annular, about an inch and a half or two inches above the anus.

If suppuration occur the abscesses may break into the bladder or vagina, or they may extend through the sacro-sciatic foramina, or even burst into the peritoneal cavity.

### Fissure of the Anus.

A distinctive name has been given to a small ulcer which occurs on the margin of the anus or on the mucous membrane just inside, because of the extraordinary severity of the symptoms to which it gives rise.

It usually lies upon the posterior wall, very often hidden by a small external pile; and so long as the anus is contracted, it has the appearance of a fissure lying between two rather œdematous muco-cutaneous folds. If, however, these are separated and the anus distended, it is seen to be a circular or oval ulcer, lying sometimes on the white line at the junction of the skin and mucous membrane,

sometimes wholly on the latter; in this case the symptoms are less severe. In some instances it is quite superficial; in others, it extends completely through the mucous and submucous tissues, and exposes the fibres of the sphincter beneath. As time passes, the edges become thick and œdematous, and, not unfrequently, the mucous membrane is undermined, so that a short sinus runs upward in the submucous tissue. Occasionally, a fold grows out into a polypoid form, and lies in the fissure when the anus is closed; and, if the disease lasts any time, the sphincter and the levator ani always become hypertrophied, from their persistent contraction, so that the orifice is tightly drawn up when the least attempt is made to expose the ulcer.

An ulcer of this kind may be formed by any slight tear or abrasion; very often, patients assign it to the passage of some especially hard motion; it is not uncommon after parturition; it may follow diarrhœa, and, not unfrequently, some syphilitic abrasion forms the starting point; or it may be due to an inflamed external pile, an irritating discharge, or chronic congestion kept up by uterine displacement. In some people, the orifice of the anus seems almost as prone to crack as the mucous membrane of the lips, but, fortunately, most of these little sores get well of themselves, or with very simple treatment; it is only a few of the cracks and fissures that give rise to the characteristic symptoms of fissure of the anus.

**Symptoms.**—Of these the chief is pain—pain of the most excruciating character, coming on as the bowels are acting, and lasting perhaps for hours without abating. It is usually described as the pain of a red-hot iron, or of violent tearing; the patient is in a state of collapse, unable to move; the pulse is scarcely perceptible; and the forehead covered with perspiration; and this, in the worst cases, may continue for almost the whole day. In others, it is less severe; when, for example, the ulcer lies above the white line, it often does not come on at once, and may only last for a short time; but, even so the patient may be entirely prevented from doing any active work. Often the symptoms are aggravated by constipation; the patient dreads each action of the bowels, and postpones it as long as possible, so that the fæces become hard and dense, and the suffering tenfold more severe. Retention of urine is a common consequence in men, and menstrual disorders in women. Dyspepsia, loss of strength, extreme anæmia, violent pains down the back and loins, and other effects soon make their appearance, until at length the sufferer and his friends are firmly convinced that symptoms of such intensity can only arise from malignant disease.

The **diagnosis** rarely presents any difficulty; neuralgia of the rectum is the only trouble likely to be mistaken for it; no other affection causes such peculiar and severe pain. Sometimes a stain of blood or mucus is noticed upon the motions, or there is a slight mark upon the skin. The anus, when it is inspected, is tightly drawn up and contracted, the glutei closely approximated, and the sphincter feels hard and firm; sometimes, there is a small external hemorrhoid near the margin, or the edge of the ulcer may be seen. Examination with the finger is so painful that, where the symptoms are well marked, it is always advisable to give an anæsthetic. The orifice then can be dilated, and, as the mucous membrane is everted with the pressure of the fingers, the whole of the ulcer becomes visible, first as a fissure, and then as a small, round, granulating surface, the base of which is sometimes covered with a thin slough.

The extreme severity of the symptoms is accounted for by the exposure of some nerve-filament upon the floor of the ulcer. The degree of pain varies very much in different cases; it is always less when the mucous membrane only is affected, and, not unfrequently, the excessive sensitiveness of the surface is limited to one or two small points, evidently spots where the nerve-fibres are lying bare.

**Treatment.**—In the early stages the ulcer can sometimes be cured by keeping the motion soft, and applying a mild astringent ointment, nitrate of mercury, calomel, or sulphate of zinc, night and morning, and after every action of the bowels; but, as a rule, something further is required. The object is to give the

ulcer perfect rest; if this can be done, and if there is no polypoid growth hanging over it, preventing its closing, it will generally heal in the course of a few days. The simplest plan is to apply caustic to the surface—nitrate of silver or the acid nitrate of mercury. The patient must be placed under an anæsthetic; the floor of the ulcer freely exposed, and then well cauterized, so as to cover it with a protecting layer. Afterward the bowels must be prevented from acting for a day or two, and the patient kept in the recumbent position, until the sore has healed.

If, however, the sphincter is hypertrophied, or if there is a polypoid growth overhanging the ulcer, this is not enough, and, in most cases, even when neither of these conditions is present, it is advisable to adopt a more thorough proceeding from the first, dividing the superficial fibres of the muscle, or stretching it so that it cannot contract. A combination of the two is the most useful, though either will succeed alone; the patient is placed under an anæsthetic, and the anus thoroughly dilated with the fingers; then, when the floor of the ulcer is exposed, an incision is made across it, about a quarter of an inch in depth, so as to divide the superficial fibres of the sphincter. If there is a small sinus under the mucous membrane, it should be slit up at the same time; overhanging edges of mucous membrane should be excised, and any small polypoid outgrowth or hemorrhoid removed as well. Complete division of the external sphincter is an unnecessarily severe proceeding; a very slight cut is usually sufficient, especially in those cases in which there is one exceedingly painful spot; if the nerve upon which this depends is divided, the pain ceases, the spasmodic contraction of the sphincter begins to relax; the ulcer is placed at perfect rest, and begins to heal at once. It is difficult, however, to make sure of doing this, and if the sphincter is very tense, stretching or superficial division is usually advisable. Sometimes the ulcers are multiple, but only one incision is required.

While the patient is under the anæsthetic, the opportunity should be taken for thoroughly examining the rectum higher up. If there is any complication present, or if in women there is any displacement of the uterus, and this remains unrectified, it is highly probable either that the ulcer will not heal, or that, if it does, it will form again as soon as the patient begins to get about.

### Fistula in Ano.

By fistula, in the general sense of the term, is meant a sinus in the neighborhood of the anus, left by an abscess which has healed up to a certain point, and then either remained stationary, or even grown worse. It may be complete with one opening in the bowel and the other on the skin; or incomplete, the internal or external opening only being present. The former of these is known as a blind internal fistula, the latter as a blind external one.

In point of importance, fistulæ may be divided into anal or rectal. The former merely occur near the margin of the anus, and are either entirely subcutaneous, or are merely covered in by some of the fibres of the external sphincter; the latter are larger and deeper, running from the ischio-rectal fossa, between the sphincters, or even above the internal one, and are often complicated by sinuses under the skin or in the submucous tissue.

The causes of fistulæ are essentially those of the abscesses which give rise to them; injury to the mucous membrane, from fish bones or other foreign bodies; tubercular deposits; stricture; extravasation in the loose fatty tissue of the ischio-rectal fossa; inflamed hemorrhoids; cutaneous boils, etc. The reason of their persistence is to be found in the mobility of the part, the spasmodic contraction of the sphincter and the levator ani, and, if there is an internal opening, the constant entrance of irritating substances from the bowel. Blind internal fistulæ are the most rare; complete ones by far the most common, although it is sometimes a little difficult to find the internal opening. Probably, most are incomplete at first, but the second opening is soon formed; the abscess, as it enlarges, works its way simultaneously toward the bowel · · · skin, and, unless it is opened

early, the mucous membrane is separated from the subjacent tissue to such a degree that it gives way by ulceration even after the pressure of the pus is relieved.

A fistula may be either a straight passage from the skin to the bowel, or it may be complicated by sinuses running from it in every direction. The most common of these is in the submucous tissue; the internal orifice is nearly always on a level with the internal sphincter, seldom more than an inch or an inch and a half from the anus; but the sinuses may run up from this under the mucous membrane for several inches. More rarely, instead of taking this direction, it passes round the bowel, causing what is known as *horse-shoe fistulæ*, and opening sometimes on one side, sometimes on both. In other cases, especially where there is a stricture of the rectum, these offshoots extend under the skin of the buttock, and even open several inches away.

The walls of a recent fistula are covered over with granulations, and secrete a thin, purulent fluid; after repeated attacks of inflammation, they become thick and dense, the lining smooth and glistening, like the surface of a chronic ulcer on the leg. The external orifice may be a mere pin-hole, or lie in the centre of a little button-like mass of granulations; or, in tubercular patients and after the rupture of a chronic abscess, there may be a large, irregular opening with undermined edges, like a scrofulous ulcer on the neck. The internal orifice presents very much the same character; sometimes it feels like a distinct little papilla resting on a base that is firmer than the surrounding parts; sometimes, on the other hand, especially in the case of blind internal fistulæ, it is a large, irregular ulcer.

**Symptoms.**—So long as there is free exit for the discharge, fistulæ merely give rise to inconvenience and discomfort. The skin around the anus is constantly moist, the surface becomes tender and eczematous, and little cutaneous boils are apt to form. In the worst cases there may be an escape of fæces and flatus through the orifice, but there is never the agonizing pain of fissure. Now and then the orifice becomes blocked; the discharge collects; the skin becomes hot, and red, and tender; the action of the bowels is attended with pain, and a small abscess forms. When this breaks, or is opened, the symptoms subside again, but each time it means either an increase in the density of the tissues around or the formation of an outlying sinus.

**Diagnosis.**—There is rarely any difficulty in this: the patient is usually aware already of the cause of his suffering; and the presence of a small orifice by the side of the anus, from which a drop or two of thin semi-purulent fluid can be squeezed, is conclusive; but this is not sufficient. It is necessary to ascertain the kind of fistula; whether it has an internal opening, and where it is; whether there are many sinuses in connection with it, and where they run; and, particularly, whether there is any cause for its persistence other than the action of the sphincter and the mobility of the part. There may be, for example, a stricture of the rectum, high up, and a complete fistula with its internal orifice in the usual situation near the anus; or, what is even more perplexing, there may be a complete fistula and necrosis of the sacrum or coccyx at the same time; the diseased bone has caused the formation of an ischio-rectal abscess, and this has led to the development of the fistula. Of course, in either of these cases, an operation upon the fistula only is worse than useless.

The patient should lie upon a couch, on the affected side, with the knees drawn up. In most cases the orifice of the sinus is visible at once, but sometimes it is very small, concealed behind folds, or closed for the time being. If it cannot be seen, the induration can nearly always be felt, even when the fistula is a blind internal one, and very often a little pressure causes a drop of pus to exude. Sometimes the whole track of the sinus can be made out with the finger.

When there is an opening a probe may be gently passed into it before anything further is done, in the hope that it may succeed in reaching the internal orifice without exciting the action of the sphincter. Usually the sinus runs almost under the skin toward the bowel. If this does not succeed the finger must be introduced and the mucous surface carefully explored just inside. Generally there

is no difficulty in feeling the opening; if, however, it cannot be found, either a speculum may be used or some milk or other colored fluid injected into the orifice; nearly always some of it finds its way into the bowel. It is a common mistake to pass the finger in too far at first and overlook the opening.

Blind internal fistulæ differ from the others. They usually communicate with the bowel by an aperture of some size; and from the fact that fæcal matter is constantly entering and setting up inflammation, they are very often attended with a good deal of pain. There is no discharge externally; but the patient is usually aware of a swelling by the anus emptying itself every now and then into the bowel with temporary relief. Digital examination nearly always reveals a hard and painful mass in the ischio-rectal fossa, and an irregular ulcer often of considerable size in the bowel. Occasionally the sac can be emptied by pressure; but to make the diagnosis certain, a probe bent like a hook must be passed down into the sinus through the anus. Fistulæ of this kind are usually caused by a foreign body perforating the mucous surface of the bowel, or by the softening of some tubercular deposit in the wall.

**Treatment.**—As a rule, fistulæ can only be cured by operation. In exceptional cases, in which there is no internal opening and in which the patient will submit to prolonged treatment, the sphincter may be stretched, the sinus stimulated with strong carbolic acid or tincture of iodine, and the external orifice kept widely open in the hope that it will close; but it nearly always ends in failure, after a long waste of time. The only method that deserves reliance is division of all the structures between the fistula and the anus, so as to lay it open from one end to the other and give it complete rest.

FIG. 414.—Grooved Probe passed through Anal Fistula before its Division.

FIG. 415.—Method of Dividing Anal Fistula.

An aperient is given the night before and an enema the morning of the operation. The patient is placed under an anæsthetic, and laid on the affected side, close to the edge of the table, with the knees well drawn up, and held by an assistant, who also raises the upper gluteal fold. The sphincter is gently dilated and a director passed from the external orifice along the sinus into the bowel. Care must be taken to bring it out at the internal opening and not make a fresh one, except in the case of a blind external fistula. Then the point of the director is brought out through the anus, so that the structures to be divided are stretched over it like a bridge, and a clean incision made through them with a sharp-pointed bistoury

If this cannot be done, the finger is introduced into the bowel, a blunt-pointed bistoury passed along the director until its end can be felt coming through the orifice, and then, after withdrawing the director, the finger and the bistoury are brought out together so as to divide with one sweep all the structures that lie between them (Fig. 415).

After this, exploration must be made for outlying sinuses. A submucous one may be laid open with a pair of blunt-pointed scissors; or if from its position there is any risk of serious hemorrhage, an elastic ligature may be passed through it by means of a suitable probe and tied as tightly as possible. Those under the skin are treated in the same way; or if they are of great length a drainage tube may be passed along them and brought out through an incision at the other end. If one is overlooked, an abscess is almost sure to form before the wound is healed, and render a second operation necessary. In the case of old fistulæ lined with a smooth layer of false mucous membrane, the walls must be scraped out thoroughly, with the sharp spoon, so as to insure removal of all the indurated mass. Polypoid outgrowths and hemorrhoids are dealt with at the same time; and loose and undermined flaps of skin are cut away, though discretion is necessary.

Any bleeding point is tied or twisted at once, the wound packed with iodoform gauze, and a firm pad placed over the anus and secured in position with a T bandage. The following day all external dressings are removed and the deeper layer allowed to separate in a bath. The wound is cleansed night and morning and after each motion, pain being prevented by cocaine, and a single fold of lint laid between the edges. The application should be varied from time to time, according to the state of the granulations. The bowel should not act for four or five days after the operation, and the motions should be kept soft until the wound is perfectly sound. The recumbent position is essential until healing is completed, although it is not necessary for the patient to be kept actually in bed for more than a week or ten days.

I have succeeded in obtaining union by the first intention by thoroughly refreshing the base of the sinus after the sphincter had been divided, and bringing the surfaces together in accurate contact with deep wire sutures. It is necessary, however, to remove them at the least sign of suppuration, or secondary sinuses may form. Probably buried catgut sutures would answer better; but this can only be tried when the fistula is recent and simple in character, and when the patient is young and healthy.

In cases in which there are deep sinuses, where there is much reason to fear hemorrhage, or where the patient is exceedingly nervous, an elastic ligature may be used to divide the tissues gradually. It should be a solid cord, passed through from the bowel into the sinus, drawn as tightly as possible, and secured by means of a leaden clamp. Generally it cuts through in from six days to a fortnight, and without pain; but sometimes it is followed by serious inflammation, and if there are any secondary sinuses present (and it often happens that this cannot be determined until the fistula is laid open), it is almost sure to fail. The length of time that the wound takes in healing is approximately the same as after other methods of division.

Incontinence of fæces is always present for two or three weeks after the operation, and inability to control flatus for some time longer; but if the sphincter is divided at right angles, and in only one place, there is seldom any permanent loss of power. According to Allingham, it is fairly safe if ever so narrow a ring of the upper part of the band of the internal sphincter is left. An exception, however, must be made in the case of anterior fistulæ in women; the sphincter vaginæ and the sphincter ani decussate in the perineum, and a free incision through the front part of the anus is not unlikely to be followed by incontinence. It is recommended in these cases to apply the actual cautery freely to the old cicatrices, and to the external and internal sphincters as well, in several places, so as to narrow the orifice of the anus by the subsequent contraction; and it is said that the muscular fibres, which are always very much degenerated, soon regain a considerable

degree of their former power, probably because the dense scars formed in this way afford a firmer and better base for their action.

Phthisical patients are exceedingly liable to fistula, but, except in cases of rapid tuberculosis, or where the patient's health is distinctly failing, this is not of necessity a bar to operation. Very great care, however, is essential; the sphincters are often weak and should be interfered with as little as possible; the diet must be good; the patient must not be kept in bed too long, and a time should be chosen when the cough is not very troublesome; but even then the wounds are not unfrequently exceedingly slow in healing.

## Stricture of the Rectum.

Stricture of the rectum may be simple or malignant. The former is either congenital or the result of injury and inflammation; the latter is always due to cylindrical epithelioma starting from the follicles of the mucous membrane and gradually extending into the submucous tissue.

In addition to this symptoms of obstruction may be caused by foreign bodies, by new growths occupying the interior of the bowel, or by tumors pressing upon it from the outside so as to close it more or less completely.

Congenital stricture occurs a very short distance inside the anus, where the rectal and anal portions of the intestine meet in the course of development. It usually takes the form of an annular constriction, and is really a minor degree of the defect which gives rise to one variety of imperforate anus.

### *Simple Stricture.*

This is much more common among women than among men, in the proportion of at least six to one. It may be annular or tubular, situated near the orifice, or at the junction of the anus and rectum, or higher up in the bowel. Generally it is single; but it may be multiple, or it may spread over a considerable extent. Sometimes it feels like a cord tied around the bowel; more often the surface is rough and irregular, deeply ulcerated in places, and covered with cicatrices in others; and the walls, instead of being soft and yielding, are hard and rigid. The muscular fibres are wasted, and the connective tissue in and around the bowel so hard and dense, that the portion involved is converted into a rigid tube, down which the fæces are forced by the accumulation above. Generally the anterior part of the rectum is more affected than the rest, and not unfrequently the fibrous tissue around it for a considerable distance is as dense and hard as cartilage. Above, the bowel is distended and its muscular coat hypertrophied; very often there is ulceration from the pressure of the fæces, and occasionally small hernial protrusions of the mucous membrane are formed, like those of the bladder in chronic cystitis. Below, the mucous membrane is always in a state of chronic congestion; and catarrh, piles, prolapse, and fistula commonly occur. Outside, in the cellular tissue around, suppuration always breaks out sooner or later, sometimes starting from the mucous surface, sometimes independently; and pelvic abscess, recto-vesical or recto-vaginal fistula, or even general peritonitis from rupture into the peritoneal cavity, may follow.

**Causes.**—Stricture close to the orifice may result from imperforate anus (the after-treatment not having been properly carried out) or from injury, ulceration around the margin, or operations upon external hemorrhoids. Higher up in the rectum, it may commence from the outside—inflammation of the cellular tissue extending into the bowel from the uterus or other organs; or from the interior, the mucous membrane becoming ulcerated and the submucous and other coats involved. The latter may be due to dysentery, a large portion of the sigmoid flexure and even of the colon being implicated; or to tubercle or syphilis, the ulceration extending more or less round the bowel. Sometimes it is the immediate result of operation, too much of the mucous membrane having been removed with

internal hemorrhoids or prolapse; more often it is due to the wound that is left failing to heal for a long time. Owing in part to venous congestion, in part to the irritation of the fæces and the constant contact with septic material, wounds of the bowel sometimes refuse to heal, and gradually extend by ulceration until, when at last cicatrization does occur, the scars are rigid and hard and extend over a considerable area. Finally, many of these cases are assigned to parturition, whether they are due to sloughing of the mucous membrane from injuries received at the time, or to inflammation of the cellular tissue around the bowel afterward.

Spasmodic stricture of the bowel, as such, has no existence, but there is no doubt that many cases of ulceration and of organic stricture are complicated, and the symptoms made infinitely more severe, by spasmodic contraction of the involuntary muscular fibre in the wall, and perhaps of the levator ani as well. Whether this, if long continued, can at length lead to atrophy and fibroid degeneration is open to question.

**Symptoms.**—The symptoms of stricture of the rectum are partly those of obstruction, partly those of irritation and inflammation. Generally the latter are present first, but sometimes, when the stricture is higher up in the bowel than usual, obstruction occurs almost without warning. Diarrhœa in the morning, on first getting out of bed, and again after food; a constant discharge from the anus, keeping the skin moist and sore, and leading to the formation of tags and fissures; a sense of fullness about the part, with persistent desire to strain; and general uneasiness about the loins and down the thighs, are nearly always present. After a while there is difficulty of defecation; attacks of constipation alternate with diarrhœa; normal motions are never passed; the fæces are in small, hard pellets, mixed with mucus, like white of egg at first, later with coffee-ground debris. The pain becomes more severe, radiating from the perineum all over the branches of the sacral plexus; the griping never ceases; the abdomen becomes distended with flatus; there is loss of power over the sphincter, so that wind and liquid fæces are constantly escaping; sympathetic troubles about the bladder and uterus set in; and the patient rapidly becomes worn out by the constant suffering.

If the disease is allowed to continue, the ulceration of the bowel becomes deeper and deeper; suppuration occurs in the tissues around, leaving fistulæ, which may open on the exterior or communicate with some of the neighboring viscera; the suffering becomes intense; and death ensues at length from exhaustion, hectic, and profuse suppuration, or from peritonitis or intestinal obstruction.

**Diagnosis.**—The diagnosis of fibrous stricture of the rectum must be made by digital examination; the finger meets either with an annular constriction, or a hard tubular canal, the walls of which are rigid and unyielding. Only in a very few cases is it too high up. By placing the patient under an anæsthetic, slightly dilating the anus, and pushing the perineum well up, the whole of the region in which fibrous stricture occurs can generally be explored. If nothing is felt, and the symptoms point definitely to obstruction, an attempt may be made to carry the examination further by the long enema tube, or by passing the hand into the bowel with the precautions already described.

Occasionally olive-headed bougies, similar to those used for examining the urethra, only on a larger scale, are of use for determining the length of a stricture.

**Treatment.**—1. *General.*—The diet must be nutritious, but such as to leave a very small residue; the motions kept soft; the bowels not allowed to act too often, and every assistance given them in the shape of enemata of glycerine or oil. Inflammation and ulceration of the mucous membrane are always present in bad cases of stricture as a consequence, if they are not the cause, and no pains should be spared to relieve them, and procure cicatrization, by rest and mild astringent ointments.

Iodide of potash should be given if there is any evidence of syphilis, with enemata of lotio nigra; but it is only of use when there are specific ulcers; it has no effect upon the scars. Cod-liver oil is of great benefit even in cases that are

not tubercular; pure milk diet may be tried with advantage for a time; and, in short, every attempt must be made to restore strength, while soothing the affected parts as much as possible.

2. *Local.—Gradual dilatation* is the most successful; forcible stretching, unless the stricture is actually at the orifice, is dangerous. Where the opening is small and the tissues dense, a laminaria tent may be used; but in most cases gum-elastic bougies of different sizes, well softened and well greased, are preferable. A small injection of oil is given first, the patient lying on his side, and the bougie very gently guided into the narrowed part, remembering that, particularly in old-standing cases, the walls are very soft in places and easily torn. As a rule, the bougie should not fit the stricture closely, but if, after one or two trials, there is no pain or sign of irritation, tapering ones may be used with caution. In some patients the bougie must be withdrawn after a few minutes; others will tolerate them for several hours, so that no definite time for their withdrawal can be mentioned. A suppository of acetate of lead and opium, or a small injection of starch and laudanum, should be introduced as soon as the bougie is removed. It is sufficient in most cases if this is done every second or third day, gradually increasing the size. Where it is possible, the treatment should be kept up until a bougie an inch and a quarter or an inch and a half in diameter will pass with ease; and even then it is essential to make use of them occasionally afterward, in order to prevent a relapse.

Not unfrequently, after the treatment has been carried out for a short time, the rectum becomes irritable; the skin round the anus red and tender; the amount of discharge increases; and there is a certain degree of feverishness. In this case, the bougies must be left off at once, the patient confined to bed, and local sedatives applied until the inflammation has subsided again. If the treatment is persisted in, ulceration, and perhaps abscesses and fistula, will follow.

*Internal division* of rectal stricture has little to recommend it; sometimes, when the constriction is near the anus and the mucous membrane only is involved, it may be practiced; but unless great care is taken, it is not unlikely to be followed by ulceration, which may be very persistent. In the congenital annular form, where the surface is healthy, and there is no induration beneath, there is not the same objection. The bowels are thoroughly opened, the anus stretched under an anæsthetic, and the sharp margin of the projecting ring divided at three or four points, care being taken not to penetrate too deeply. The patient is kept lying down, and the bowels confined for three or four days; then a purgative is given, and, after the motion, the mucous membrane is thoroughly washed out with a weak antiseptic. Bougies should not be passed for two or three days, and the finger should be carefully introduced first to make certain that the wounds are healed.

Electrolysis has been tried for stricture of the rectum, as for the stricture of the urethra, the negative electrode being applied to the face or the interior of the narrowed part; but, except that it is, perhaps, more rapid in its action, it is doubtful if it possesses any advantage over gradual dilatation, and it is certainly more likely to be followed by irritation and ulceration.

*Linear Proctotomy.*—Unless great care is taken, and bougies are passed at frequent intervals, relapses are almost sure to occur, sooner or later, except, perhaps, in the congenital form. Each time the stricture becomes harder and denser, and at length more or less of the bowel is converted into a rigid, unyielding, cartilaginous tube, with, perhaps, abscesses and fistulæ around it. If this is within a short distance of the anus, an attempt may be made to relieve it by what is known as linear proctotomy. The rectum is thoroughly washed out, the patient placed in the lithotomy position, and the finger passed through the stricture, some of its fibres being divided to effect this if necessary; and then, with a long, curved, sharp-pointed bistoury, the whole of the stricture-tissue is divided as near the middle posterior line as possible, right down to the sacrum, and out at the anus. Sometimes there is free hemorrhage, especially high up at the angle of the wound, and to avoid this it has been recommended to use the écraseur; but it can usually

be checked without difficulty by pressure. The operation is followed by profuse suppuration; but the drainage is good; there is free escape for the pus; and the part is placed at perfect rest. All that is required is that the cavity should be well irrigated once or twice a day. As soon as the wound is granulating freely and the sloughs have separated, generally at the end of a week or ten days, a soft bougie may be passed, to prevent recontraction.

*Colotomy.*—Finally, where this has failed or is impracticable, when there is obstruction owing to stricture high up in the bowel, or when there are fistulæ, especially if they communicate with neighboring viscera, colotomy is the only resource.

### *Malignant Stricture.*

*Epithelioma of the anus* is not a very common affection. It is always the squamous-celled variety, and usually commences as a small nodule or wart, which may at first be mistaken for an external pile. Before long, however, the surface breaks down and ulcerates, and a sore is left, which, if it lies on the junction of the skin and mucous membrane, may be as painful as fissure.

*Epithelioma of the rectum*, on the other hand, is of very frequent occurrence, and like that which is met with elsewhere in the large intestine, may appear not only in old age but during young adult life. It may involve any portion of the bowel; but usually there is a clear ring of mucous membrane for an inch or so just inside the anus; and not unfrequently the surface is free as far as the junction of the sigmoid flexure with the rectum, so that the growth is out of reach of the finger.

Its appearance varies very much in different cases. At the very commencement there may be merely a hardened, slightly raised patch, seemingly covered by the mucous membrane; soon, however, this begins to spread, both in extent and depth. The surface becomes rough and uneven; sometimes it grows out in the form of a nodule, which projects into the bowel and attains a very considerable size before it breaks down; more often it begins to ulcerate almost at once, and the destruction may extend so deeply as to leave but little of the growth at the base. The margins of the sore are raised, thickened, and hard; generally they are very irregular in outline; the base is exceedingly uneven, not unfrequently covered with sloughs, and at times bleeds freely; and the tissues lying beneath it are as hard as cartilage, and so fixed as to be quite immovable. Very often the ulcer surrounds the intestine like a ring, and the contraction of the tissues outside is so great that, in spite of the destruction, the canal is almost, if not altogether, closed; in other cases it forms a deep excavated sore on one side or behind, extending far beyond the limits of the bowel; and in others, again, the whole of the interior of the tube for some inches is ragged and irregular on the surface, so that nothing can be felt but the breaking down epithelial growth.

The starting point of the growth is undoubtedly in connection with Lieberkühn's follicles, and in every example some portion of the tumor can be found with the characteristic adenoid structure of cylindrical epithelioma; but in some cases the epithelial element is in excess, and large vascular masses of new growth are formed, soft, like encephaloid, and sprouting into the interior of the bowel; in others the fibrous part is more developed, and the base of the ulcer, the muscular coat of the bowel, and the fatty tissues around are infiltrated with a dense cicatricial mass to such an extent that when cut across it has all the appearance of scirrhus. The sacral and coccygeal glands are not involved till late; secondary deposits, unless the case terminates early, are usually found in the liver.

Colloid degeneration of small portions of the growth is not uncommon, and little masses like boiled sago may be frequently found here and there in its substance; much more rarely the whole growth is involved. Other forms of malignant disease are very rare. One or two examples of sarcoma are recorded, and melanotic growths have been known to occur.

**Symptoms.**—The onset is peculiarly insidious, and, especially when the

growth involves the upper part of the rectum, and assumes the annular type, complete obstruction may occur suddenly and without warning of any kind, the orifice being blocked either with a small mass of hardened fæces or by a fold of the mucous membrane. As a rule, however, all the symptoms of non-malignant ulceration and stricture are present in an aggravated form.

At first there is merely an uneasy consciousness of the existence of the part, with a certain amount of irritation about the anus; or there is a slight discharge of blood-stained mucus, and the patient imagines that he has piles; then it becomes distinctly painful, especially after exercise or when the bowels have acted. Sometimes this pain is of a dull, aching, continuous character; or more often it takes the form of violent neuralgia, shooting down all the branches of the sacral plexus, especially on the left side. Occasionally it is relieved by the passage of the fæces; much more often every action of the bowels makes it tenfold worse, and, in spite of the constant desire and sense of fullness in the rectum, the patient looks forward to it with dread. As the passage becomes narrowed, the straining and tenesmus grow more and more severe; the fæces come away in hardened lumps; attacks of constipation alternate with a kind of spurious diarrhœa; a blood-stained and very offensive discharge is continually oozing out; the skin becomes inflamed and sore; prolapse of the mucous membrane or hemorrhoids occur; abscesses, with violent throbbing and high fever, form in the cellular tissue around, and leave behind them fistulæ, which may open on the exterior or communicate with the bladder or vagina; and at length the patient becomes utterly worn out by the suffering.

Death may be caused at any time by peritonitis, hemorrhage, or obstruction; or, if no complication of this kind sets in, secondary deposits make their appearance in the liver, the legs begin to swell, there is complete inability to take any food, night sweats come on, and the patient sinks from exhaustion, worn out by the constant pain, and emaciated to the last degree. The duration is very variable, and, owing to the insidious character of the earlier symptoms, exceedingly hard to estimate. As a rule, it is very much more rapid in the young than in the old; some of the quickly-growing fungating forms prove fatal within a few months; others, in which the hard and dense fibrous stricture tissue predominates, last for five and even six years. Unless some accidental complication appears, three years may be taken as the average.

**Diagnosis.**—In advanced cases there is no difficulty; the severity of the pain, the peculiarly offensive character of the blood-stained discharge, and the appearance of the anus, surrounded with piles and inflamed folds of skin, are sufficient. If the finger is introduced, it comes into contact with a hard, uneven stricture, generally about two inches from the anus. The orifice is often very small, and any attempt to pass even the tip through is attended with extreme pain; the surface is rugged and dense, but breaks down at once with pressure, bleeding freely; and above there is a large, irregular cavity, the walls of which are ulcerated all over. It is only in very extreme cases of syphilitic or dysenteric ulceration that anything similar is produced. In the earlier stages of the disease, which are rarely seen, careful examination is necessary, especially as this form of carcinoma is not at all uncommon in young adult life, and any growth in the bowel which is surrounded by induration, or which cannot be moved freely upon the subjacent tissue, should be regarded with very grave suspicion, and a thorough investigation under an anæsthetic, with the anus well dilated, insisted upon.

When the growth occurs in the higher part of the rectum, above the reach of the finger, the patient may complain of attacks of diarrhœa alternating with constipation, but as a rule nothing else is noticed, until the constriction is far advanced and obstruction imminent.

**Treatment.**—1. *Radical.*—In all cases in which it is possible to remove it thoroughly, the affected portion should be excised without delay. It is very difficult to say how long a patient affected with carcinoma of the rectum may live without operation, but there is no question that, if the diagnosis is made before

the disease is far advanced, and the whole of it is removed, it may be years before there is any recurrence; and, in the meanwhile, at the risk of what is not at that time a serious operation (whatever it may be later), the patient is relieved from a source of unceasing pain. For this to succeed, however, certain conditions are essential. The patient must be in a good state of health; extreme old age is, of course, a bar, but even quite late in life, if the kidneys are sound and the patient is not plethoric, excision is successful, provided the local conditions are good. The growth must be within a reasonable distance of the anus; that is to say, the finger must be able easily to reach above its highest limit all round the bowel. In the female, the peritoneal fold is usually less than three inches from the anus; in the male it is an inch higher, and it may be raised still more by moderate distention of the bladder; so that, especially in the latter case, a very considerable portion of the bowel may be removed. If, however, the anterior surface is involved high up, an operation is rarely advisable, not so much from the fear of opening the peritoneum, as because the growth is almost sure to have extended to it. Further, the wall of the rectum must be freely movable on the outside tissues. The case is most favorable when the disease is limited to the posterior wall or the sides of the bowel. If it involves the anterior surface to any extent, or if it has formed a complete ring, there is almost sure to be extensive infiltration of one part or another. In this respect, again, the prospect is distinctly not so good in women as it is in men; the vagina becomes implicated much sooner than the prostate; and though, according to Cripps, the operation is practicable so long as the vaginal mucous membrane remains free, it becomes very much more serious. Finally, there must be no secondary deposit in the liver, and no glandular enlargement, either sacral, or, if the anus is involved, inguinal.

*Excision of the Rectum.*—The patient is prepared in the usual way, by enemata, placed under an anæsthetic, and secured with Clover's crutch. The incisions are: (1) a crescentic one on each side, surrounding the anus (through the skin, if the external sphincter must be removed; through the mucous membrane inside the bowel, if this is not affected), and (2) a median one running back from this to the tip, or a little to the left side of the coccyx. The former should open up the ischio-rectal fossæ thoroughly on each side; the latter should divide the posterior wall of the bowel, from above the growth down its whole length. It is usually recommended to make the vertical one first, by transfixion with a sharp-pointed bistoury, from within the bowel, as this enables at once a thorough examination of the growth to be made in every direction.

The levator ani must be cut through with scissors, the anterior wall dissected off the prostate or vagina, as the case may be (a catheter or the finger being used to give notice of any approach to these organs), and the sides of the bowel separated as high up as required. As soon as it is thoroughly detached, the lower end is carefully cut off with stout curved scissors, clamps being placed at once on any vessels that bleed. If the peritoneum is widely opened, it must be secured with sutures; under other circumstances the sides of the wound fall together.

The bowel should not be drawn down and sutured; the tension is too great, and it encourages the retention of the wound secretion. A large drainage tube should be inserted, and the whole cavity lightly plugged with iodoform gauze. This may be allowed to come away of itself in forty-eight hours, by placing the patient in a warm boracic bath.

As a rule, granulation and cicatrization are very rapid, and but little after-treatment is required; the upper end of the bowel is drawn down and the sides fall together. As soon as healing is well established, a bougie should be passed at frequent intervals as often as required; or if this is not sufficient, the patient should wear a suitably shaped vulcanite plug.

The operation is a severe one even when the peritoneum is not opened; but if the removal is complete and early, there is no doubt the duration of life is prolonged. The degree of comfort depends upon the success with which contraction

is avoided. In rare cases the patient regains control (this is one reason for leaving the external sphincter when possible); more frequently they are comfortable so long as there is no diarrhœa, but a bougie must be used regularly. Occasionally the cicatrization is very obstinate. If a strip of mucous membrane can be left the contraction is less severe, but the risk of recurrence is greater.

*Resection of the Rectum.*—In Germany operations on the rectum have been carried very much further than in England. Kraske, of Freiburg, for example, does not hesitate to remove the coccyx, divide the left sacro-sciatic ligament, and, if necessary, chisel off part of the sacrum. In this way the side of the rectum is exposed, the diseased part can be freely excised, and the upper end of the bowel drawn down and secured to the lower.

Bardenheuer does not limit the operation to malignant growths, but includes cases of recto-vaginal fistulæ with a very large defect or with considerable kinking of the bowel, and some cases of stricture (although the presence of inflammatory adhesions usually prevents this). The whole of the rectum and part of the intestine above (upward of ten inches) have been removed.

The incision runs from the posterior margin of the anus to the middle of the sacrum; the soft parts are detached from the bone, the sacro-sciatic ligaments divided, and the sacrum itself cut across at the level of the third vertebra. The wound is widened by tearing the tissues in the middle line with the index fingers, and everything on the inner aspect of the levator ani that surrounds the bowel is detached by degrees until the rectum (below the growth) is thoroughly isolated. A loop is then passed round it, the peritoneum separated off (opened if necessary), and the bowel drawn down and divided about an inch and a half above the growth. The mucous and muscular coats are then united by separate sets of sutures and the wound plugged with iodoform gauze.

2. *Palliative.*—Where excision of the disease is impracticable the only thing left is to render the patient's life as endurable as possible and treat the symptoms as they arise. The general treatment must be the same as in ulceration and stricture due to other causes: the motions must be kept soft and small, the diet must be nutritious and easily digested, and the pain relieved by sedative injections, but care should be taken to avoid establishing a morphia habit in the earlier days of the disease; in the later ones it cannot be helped. Diarrhœa must be checked at once by starch and opium; the less frequently the bowels act the better, so long as there is no obstruction. Constipation caused by early contraction of the stricture is more difficult to deal with; as a rule, when the disease is high up, it is an indication for colotomy; but if it is quite close to the anus, and an operation is not thought advisable, relief may be obtained by bougies; this, however, is only practicable in exceptional cases, and even then the pain is so severe, and the risk of perforating the bowel and setting up inflammation around it so great, that it can scarcely be recommended. Sometimes, when there is a great fungating mass in the interior of the bowel, it is possible to tear it away or scrape it out, the anus having been dilated first, so that there may be free access to every part; and it is said that if the operation is rapidly performed, there is but little hemorrhage; but every precaution should be taken beforehand. Finally, if obstruction sets in, if fistulæ form, whether they open on the exterior or into one of the neighboring viscera, or if there is intense pain caused by the passage of the fæces over the ulcerated surface, colotomy should be performed, as already described, either in the inguinal or lumbar region. Unhappily, it can do little or nothing in the way of relieving the intense neuralgia which is caused by the disease involving the sacral plexus.

### Villous Tumor of the Rectum.

Villous growths, similar to, but rather coarser than the fimbriated papilloma of the bladder, are occasionally met with in the rectum. Allingham, who has had the widest experience of them, describes them as forming a soft, lobulated, spongy mass, either sessile, or with a pedicle formed from the subjacent mucous membrane.

In most cases they grow from the posterior wall rather high up, and by far the greater number occur in people over fifty years of age. In some they caused severe hemorrhage, and the growth occasionally became prolapsed; but the most striking feature is the constant discharge of large quantities of thin, watery mucus. The diagnosis, unless some portion of the growth is forced out through the anus, is exceedingly difficult, owing to the peculiar soft, velvety feel of the mass, which prevents its being distinguished from the natural folds of the mucous membrane. The only treatment is free excision; and this is especially necessary, as in a large proportion of cases malignant disease followed.

Nævus of the rectum is occasionally met with, and may give rise to very profuse hemorrhage.

# CHAPTER XX.

## INJURIES AND DISEASES OF THE KIDNEYS.

### ABNORMALITIES.

#### Form and Number.

The kidneys are occasionally united together more or less closely. There may be only a fibrous band between them, or the upper or lower ends may be joined together, so as to form a horseshoe-shaped mass in front of the vessels; or they may be fused into an irregular disc, lying somewhere near the middle line and not unfrequently as low down as the sacrum (Fig. 416). As a rule there is but little inconvenience from this; but cases are recorded in which thrombosis of the great veins and hydronephrosis have occurred: and in one instance the pain during the menstrual period was so great that an operation was undertaken for the removal of the offending mass without its being known that it was the only kidney.

#### Size and Position.

Variations in size are still more common. One kidney may be absent, and that one without the other showing any remarkable change. Both ureters may be present arising from the single kidney, one crossing to the other side. More often, without being altogether deficient, one kidney is so small that it is doubtful whether it could single-handed be sufficient for the work of the body. This occurs so frequently as the consequence of disease that in all cases in which the removal of a kidney is contemplated it is essential to obtain definite information with regard to the efficiency of the other.

The vessels are often abnormal, both in number and origin. The most serious anomaly is when an artery arises from the aorta higher up or lower down than ordinary, and runs to the lower pole. This is said to occur about once in a hundred. The ureter may [illegible] the whole of its course. Usually it [illegible] is compressed by [illegible] there is a valve of [illegible] to the flow of urine. [illegible] the existence of a [illegible] Sometimes they [illegible] and they may be [illegible] the menstrual period,

or from acting as an obstruction during parturition. Pressure as a rule causes a peculiar sickening pain, and sometimes after handling blood appears in the urine.

### Movable and Floating Kidneys.

Owing to the loose character of the surrounding tissues, the kidneys are always slightly movable. If the lower end is exposed from the loin it may be seen to ascend and descend with respiration; and it can be pressed forward with the finger or pushed back again by the hand upon the abdomen. When this movement is so free that it can be felt plainly from the outside, the kidney is said to be movable; it is floating if the range is greater still, so that it comes into contact with the front wall of the abdomen. In the latter case there may be a mesonephron, or fold of peritoneum investing the kidney like a portion of the small intestine, but it is very unusual.

Movable kidney is more common on the right side than on the left, and in women than in men. The former fact is probably to be accounted for by the downward pressure of the liver and by the shortness of the left renal artery; the latter by various reasons, of which the use of stays, the effect of repeated pregnancies, causing great relaxation of the abdominal wall after great tension, and the comparatively sudden alterations in the amount of perirenal adipose tissue common under the same circumstances, are the most important. Conditions like hydronephrosis, calculus, or new growths, which increase the weight of the organ, may assist, but of themselves are scarcely sufficient. In most cases the immediate cause is stated to be an accident of some kind, such as a fall in the sitting position.

**Symptoms.**—Sometimes a floating kidney merely causes inconvenience; sometimes, on the other hand, even when it is only slightly movable, it gives rise to intense suffering. A feeling of weight or of dragging, or of something being loose, is always present, and during the menstrual period and after exertion is very severe; riding is out of the question; and stooping and walking are very painful. Attacks resembling renal colic, attended with vomiting and great prostration, are of frequent occurrence; occasionally there is jaundice, or œdema from pressure upon the veins; sometimes the ureter becomes partially blocked from twisting, causing temporary hydronephrosis; dyspepsia and loss of health and strength are almost always present, and in many cases the patients become hysterical or hypochondriacal, so that they have even been known to make away with themselves.

The shape of the kidney can sometimes be recognized through the abdominal wall; the patient should be placed in the recumbent position with the hips well flexed; and if there is much pain or tension, an anæsthetic may be given. If the organ is not much out of place, it can usually be grasped between the hands, one buried deep in the flank, outside the erector spinæ, the other working downward on to it; in other cases, when it lies in the iliac fossa or on the crest, the outline can be felt at once. Very often a better idea may be obtained by placing the patient upon the hands and knees, that the weight of the organ may bring it forward. Percussion in the flanks is rarely of much service; and unless the handling is very rough or the kidney diseased, there is no reason why the secretion of urine should show any change.

There is some reason to believe (though it cannot be considered proved) that movable kidneys, independently of the accidents that may befall them from twisting of the ureter, are more liable to be affected by disease than others.

**Diagnosis.**—Floating kidney itself is rarely mistaken, but many other conditions have been taken for it. Distended gall-bladders, fæcal masses in the colon, omental cysts, tumors of the pancreas, carcinoma of the pylorus, ovarian cysts, floating spleen, and many others having been diagnosed as such, and in some instances the mistake was not apparent until the abdomen had been opened. Even when the tumor is superficial, it is easy to be misled by a vague resemblance

in shape; when it is deep and scarcely movable, there may be nothing but the peculiar character of the renal pain to serve as a guide.

**Treatment.**—In the slighter cases the patient may be fitted with an elastic abdominal belt, reaching well down to the pubes and Poupart's ligament, with an air-pad over the displaced organ to hold it up and press it back into the loin. Violent exercise, especially riding, or anything attended with jolting, must be avoided. If attacked by renal colic, the patient should be placed in bed, the bowels well opened, and dry cups and hot fomentations applied over the loins. If this does not give relief, and the condition of the patient is such that it is necessary to adopt a more active line, the kidney may be exposed in the loin and stitched *in situ* (*nephrorrhaphy*). The incision is almost the same as for lumbar colotomy; the structures are divided in the same way, and the perirenal fat exposed. This should be freely divided, and (while an assistant from in front pushes the kidney back into its place) several catgut sutures passed through its capsule, so as to fasten it to the lumbar aponeurosis over as wide an area as possible. A drainage tube should be introduced down to the surface of the kidney, with the view of exciting a certain degree of inflammation. Probably, the ultimate benefit many of these cases derive is dependent more upon the adhesions that form around the kidney than upon the sutures, which must soon be absorbed.

A healthy kidney should never be removed merely because it is floating, but a large proportion of true floating kidneys are diseased in some way or other, and then the conditions are completely altered. The abdominal operation is always preferred in these cases, as it enables a better idea to be formed, not only of the diseased kidney, but of the other one.

## INJURIES OF THE KIDNEY.

### Contusions and Lacerations.

Tearing or bruising of the kidney is usually the result of direct violence, such as a blow upon the lumbar region, or crushing, as in railway accidents; or it may be produced by a sudden fall in a sitting position. The extent varies from merely a superficial contusion to complete disorganization, and the symptoms depend partly upon the hemorrhage and the escape of urine, partly upon the injury inflicted on neighboring structures.

*Hemorrhage.*—The amount of blood lost is very variable; in injuries of the cortex only there is rarely very much, but if the rent traverses the hilum, or one of the larger arteries has given way, particularly if the peritoneum is torn so that there is a large space for it to collect in, the patient may bleed to death. Usually, it pours down the ureter and collects in the bladder, either at once, or after an interval of a few hours. If the quantity is large, coagulation is not uncommon, and long, worm-like clots may form in the ureter, giving rise to the symptoms of renal colic, or even causing obstruction and hydronephrosis. In other cases, the bladder becomes filled; there is severe pain over the pubes and at the end of the penis, and, if means are not taken to break up and remove the coagula, decomposition may occur, and cause acute cystitis. The color at first is bright; but, unless the hemorrhage persists, in a day or two it becomes smoky, and then gradually clears up.

Hemorrhage around the kidney may occur in severe injuries; a swelling forms rapidly over the loins, and, later, staining makes its appearance in the inguinal region, and even in the scrotum, as the blood-stained serum travels downward along the course of the vessels.

*Extravasation of urine* is rare, unless the pelvis of the kidney or the ureter is torn. Sometimes it escapes into the peritoneal cavity; more frequently it collects in the loose cellular tissue around the kidney, and, setting up a certain amount of inflammation, gradually forms a thin-walled cyst, which grows larger

and larger, until it can be felt from the loins to the abdomen. This has been called *spurious* or *traumatic hydronephrosis*, but the condition is entirely different. As a rule, after a few days or weeks, the extravasation becomes general, and either acute peritonitis sets in, or the patient sinks from septic absorption, caused by the suppuration and sloughing around the kidney.

The other symptoms are not characteristic. Pain is always present, usually of a peculiar, sickening character, especially when any pressure is made upon the part, and, in many cases, it radiates down the thigh or to the testicle. All over the lumbar region there is great tenderness. The muscles, both of the abdomen and in the loins, are rigidly contracted; the body is bent to the injured side and the hip is kept in the flexed position. Sometimes there is pain along the course of the lumbar plexus, and very often the testicle is retracted up to the ring; but, if the injury is confined to the kidney, shock is rarely very severe. When the patient is much collapsed, there is always reason for fear either that the peritoneum has given way, or that the hemorrhage has been extensive.

Injuries of the kidney may be followed by true hydronephrosis from occlusion of the ureter; by peritonitis from extravasation of the urine or extension of the inflammation; or by suppurative nephritis and pyonephrosis, the suppuration occurring partly in, partly around the kidney. When this happens, if the patient survives, urinary fistulæ are sometimes left, discharging through an opening in the loin, or in the inguinal region. In one or two instances, total suppression of urine has followed, possibly from obstruction to the renal vessels, but almost certainly in one case at least from the reflex influence of the nervous system. The same thing has been known to occur after operations on the kidney.

The prognosis depends upon the extent of the injury and the nature of the complications that follow. The majority recover without consequences of any kind; but, if there is extravasation of urine, or much loss of blood, either at once or later, from giving way of the clot or the formation of an aneurysm, the question becomes very serious. Recovery, either complete or with the formation of a fistula, may take place even after suppuration; general peritonitis is almost hopeless, as this rarely comes on unless the injury is very extensive.

**Treatment.**—In the slighter cases all that is necessary is to confine the patient to bed on low diet, and empty the colon thoroughly by enemata. If bleeding continues, the side may be bandaged, or Leiter's coils arranged over the lumbar region, and half-drachm doses of liquid extract of ergot given every two or three hours,* only allowing the patient small quantities of ice to suck. A small amount of clot in the bladder may be left to soften and come away of itself; but, if there is much distention or pain, it should be withdrawn with one of Bigelow's evacuating tubes and a suction apparatus, for fear of decomposition and cystitis. If the hematuria persists, and it is almost certain from the amount of blood that is lost, and the rapidity, that some large branch is torn, an incision should be made in the loin, and, if the bleeding cannot be checked by ligature or plugging, the kidney must be excised.

Extravasation of blood around the kidney may be treated in the same way. If the swelling is very large and threatens to suppurate, the bulk of it may be reduced by aspiration, and subsequently the abscess opened and drained. When it is due to urine, the swelling rarely appears until some days have elapsed, and the diagnosis cannot be certain until some of the fluid is withdrawn. If this contains urea, and if it can be shown by the aid of the cystoscope that no urine enters the bladder from the corresponding ureter, nephrotomy should be performed at once, the most convenient time being chosen after the patient has rallied from the shock, before there is any septic absorption. In other cases aspiration may be tried, and then, if necessary, incision—the fistula, if it persists, being dealt with later.

* [Pills of gallic acid will also be found useful.]

### Wounds of the Kidney.

The kidney may be wounded, either through the loin or the abdomen; in the latter case the peritoneal cavity is opened, and probably other organs injured as well. In one or two cases prolapse has occurred, the whole organ being squeezed out through a wound in the loins.

The symptoms are the same as in contusion of the kidney, with, in addition, those due to the wound. The prognosis depends upon the nature of the injury; incised wounds heal readily; gunshot injuries, on the other hand, are very likely to be followed by suppuration and sloughing; but extensive urinary infiltration is not common. The lumbar plexus may be torn, the colon opened, and even the peritoneal cavity traversed by a bullet, without the result being fatal. Fistula however, and serious bladder troubles, phosphatic calculus and cystitis, not unfrequently make their appearance afterward.

Hemorrhage should be checked as soon as possible, and any foreign bodies that can be found removed at once, but prolonged exploration with a probe in order to find a bullet is not advisable. The wound should be left open; and, as there is always a tendency for it to become valvular, a large tube should be introduced down to the bottom. Later on, if suppuration occurs, free incisions are necessary. In prolapse of the kidney, if it is much injured, a ligature should be placed around the pedicle and the organ removed; in other cases an attempt may be made to return it.

## SURGICAL AFFECTIONS OF THE KIDNEYS.

### Suppression of Urine.

The secretion of urine may be checked in various ways. A calculus may be impacted in the ureter; acute nephritis may set in; or some sudden shock may give the circulation such a check that the blood pressure falls too low; and this may happen even when the kidney is healthy. If it is already diseased—if there is, for example, chronic interstitial nephritis, so that the secreting power is already impaired, and the fibrous tissue is hard and unable to accommodate itself to rapid changes in the blood supply—a very trivial reason is sufficient, and a cause that in a healthy kidney is scarcely enough to bring on a transient flushing, may be followed by such congestion as to stop the secretion altogether.

**Causes.**—1. *Shock.*—Suppression of urine may come on suddenly from one instant to another, from shock. The passage of a catheter may cause it, even when the kidneys are sound; if they are diseased, not only is this more likely to happen, but when it does it is infinitely more serious. In the one case it is transient (though instances to the contrary are not unknown); in the other it may be final. This is one of the chief reasons why operations on the urinary organs are a matter of such grave consideration when the kidneys are diseased. So long as no extra strain falls upon them they may be equal to their work; the least disturbance, reflex or direct, is enough to stop the secretion altogether.

The way in which the suppression is caused is not always the same. It is due, no doubt, to the influence of the nervous system; but in some instances the nerves of the kidneys only are involved, in others the effect is general. In the former case there is intense renal congestion; only a small amount of fluid is excreted; its specific gravity is high, and often it is mixed with blood. In the latter the pressure is so low that, as in injuries to the upper part of the spinal cord, or in the shock that is associated with injury to the peritoneum, the blood lies almost stagnant, and no urine at all is formed. In the vast majority the secretion recommences of itself; but the result may prove fatal, either from general shock or from persistence of suppression, especially when the cause is a continuous one, such, for example, as a catheter tied in the urethra. It happens in women as well as in men; it has been known in children; and it is especially common after

injury to the urinary organs, excluding the penile urethra. Nephrotomy on one side has been known to cause suppression on the other, so that there was for some time reason to fear that there might be only one kidney; calculus impacted in the ureter nearly always gives rise to it; there is hardly an operation about the bladder which it has not some time followed; while it is notorious after passing a catheter through the fixed portion of the urethra, especially in cases of recent stricture; in old ones the mucous membrane and the nerve endings in it seem to lose their sensitiveness altogether.

2. *Acute Inflammation.*—Scarlet fever, cold, cantharides, extensive lesions of the cutaneous surface, and other causes occasionally lead to such extreme congestion as to cause suppression. The kidney becomes immensely swollen; the capsule is so stretched that it flies apart if it is divided with a knife; the cortex is thickened and either deeply congested or paler than natural, according to the relative amount of vascular and epithelial change; and the urine (such as is secreted) is stained with blood, of high specific gravity, and loaded with albumin.

Gradual suppression is met with chiefly in suppurative pyelonephritis. This is the condition which has received the exceedingly misleading name of *surgical kidney*, and which so frequently proves the cause of death in cases of long standing stricture or enlargement of the prostate. The kidney is already in a state of chronic inflammation, the interstitial connective tissue is hard and dense, the secreting structure proportionately degenerated, and the specific gravity of the urine constantly too low; suddenly some irritant (a catheter, or ammoniacal decomposition of the urine) causes acute inflammation of the bladder; the ureters, the pelvis, and the substance of the kidney speedily become involved by direct extension; suppurative pyelonephritis sets in; a number of minute abscesses make their appearance in the cortex; the circulation becomes more and more embarrassed, the secretion more and more difficult, and in a few days or weeks the patient sinks into a low typhoid state with partial suppression of urine.

3. *Obstruction of Ureter.*—Sudden closure of one ureter is usually followed by intense congestion of the corresponding kidney, and partial suppression of urine in the other from shock. If the obstruction continues the latter usually recovers, but the former gradually becomes more and more dilated, until at length hydronephrosis follows.

If one kidney is destroyed in this way, the other, provided it is healthy, undergoes compensative hypertrophy to make up the deficiency; and the urine that collects behind the obstruction is pale, of low specific gravity, with a diminished amount of urea, and sometimes a small quantity of albumin. If, on the other hand, the second kidney is actually or practically non-existent, suppression is complete from the first, without any warning other than that given by the previous attacks of renal colic.

In one lady under my care total suppression had already lasted nine days (there was a history of a previous attack that had continued for six, and had at length yielded with the passage of much blood and gravel). On the tenth day I opened the kidney on the left side through the loin, and found the pelvis at an enormous depth, but no calculus could be detected, even with a probe. The patient, who was at the time suffering from the most intense muscular weakness, rallied and lived for a month. *Post-mortem* it was found that the right kidney and the right ureter were completely absent; the left measured eight inches by four, and was somewhat displaced; there was a large calculus impacted low down at the junction of the pelvis with the ureter.

**Symptoms.**—Suppression of urine is in itself only a symptom, and the consequences that follow naturally depend upon the cause. *When it is the result of shock*, whether this is due to severe injury to another part of the body, or is the consequence of an operation upon the urinary organs, the secretion may return within a few hours, before any harm is done, or the shock may prove fatal.

In *nephritis* the symptoms are to some extent the result of the suppression. The acute form—that, for example, which occurs after scarlet fever—is seldom

c disease, it rarely reaches the middle line, or extends so far down into the is that the hand cannot be introduced beneath it. New growths of the kidney isually so soft as to give the sensation of fluctuation.

The relation of the tumor to the colon is most important. It depends to e extent upon the side; on the right, as the kidney enlarges, the cæcum and lower part of the colon are pushed back to the outer side of the tumor, while upper part crosses obliquely in front. On the left side the colon lies well in t, and can be felt as a rounded cord rolling over and over under the finger; if it is filled with air, a line of resonance can be made out where the kidney is ussed. It very rarely happens that a coil of intestine intrudes itself between liver or the spleen and the abdominal wall. Resonance in the flanks is never ent when there is a renal tumor of any size.

Finally, in case of doubt, the kidney may be explored behind the peritoneum an aspirating needle. It may be introduced just at the outer edge of the or spinæ, on a level with the first lumbar vertebra, or, if the kidney is ged, midway between the last rib and the crest of the ilium; and the direction e needle should be forward and a little downward—in fact, as nearly as pos- toward the umbilicus. As a rule, if the trocar is about four inches long, e is no fear of injuring any important structure, and the sudden cessation of tance, as soon as the shoulder of the instrument enters an open space, can be ut once.

### *Cysts.*

Cystic disease of the kidneys, like hydronephrosis, may be either congenital quired, and may occur on one side or both. In many instances the whole consists of nothing but cysts, of all sizes, from a pea to an orange, so that th are affected, there is practically no secreting substance left. Not unfre- ly, on the other hand, its existence is never suspected at all, and it is only vered *post-mortem;* the only symptom is the persistent low specific gravity of ine, and even that is not invariable. Occasionally, in adult life, the cysts ge to such an extent that the tumor becomes the source of serious trouble pressure upon neighboring organs.

The cysts usually contain an albuminous fluid with a small quantity of urea: onally uric acid is found as well, and not unfrequently traces of old hemor- s. The consistence, however, may be so thick as to resemble colloid. The are always thin, and lined with a single layer of flat epithelium. In most they originate from the urinary tubules, which have been blocked, either by mation and degeneration of the epithelial cells (caused possibly by the ts of uric acid that are found in the kidneys shortly after birth), or by the ization of lymph thrown out around them. Sometimes they may be derived the glomeruli.

As a rule, these cases do not admit of treatment. When there is an enormous gement on one side, an attempt may be made to obtain relief by aspiration nephrotomy; and if it can be shown that the opposite kidney is, if not , at least capable of doing the whole work of the body, nephrectomy may be rmed, but not otherwise.

Besides these, cysts, sometimes of considerable size, are of common occurrence nular kidneys, but they seldom require treatment. Dermoid cysts are occa- lly met with, and they have been diagnosed by the passage of hair and debris the urine. Hydatids are not common; when they occur in the substance of idney they usually rupture into the pelvis, and the discharge of the daughter- may give rise to repeated attacks of renal colic. They may be treated either piration or by free incision and drainage; if left to themselves, they some- dry up and give no further trouble; but not unfrequently they suppurate, hen they must be treated by free incision, in the same way as other renal perinephritic abscesses.

### *Solid Growths.*

New growths in connection with the kidney are nearly always malignant (carcinoma or sarcoma). Tubular adenoma, fibroma (originating from the capsule), papilloma (growing in the pelvis, and resembling the villous tumors of the bladder), angeioma, and lymphadenoma, have been described, but they are all very rare. Besides these, fatty tumors are said to occur, but it seems probable that they are really derived from portions of the supra-renal capsule detached from the main body in the course of development.

Carcinoma rarely occurs before adult life, and is most common after forty. It seems especially prone to attack floating kidneys, and is not unfrequently associated with calculus, though it is difficult to be certain of the relationship that exists between them. It is nearly always encephaloid, though a few cases are recorded in which the fibrous stroma was so dense as to deserve the name of scirrhus; colloid may occur secondarily. In many cases they originate in the structures about the hilum, and only penetrate the pelvis after a certain length of time, pushing the renal structure before them; and perhaps this may explain the frequent absence of diseased products in the urine.

Sarcomata may be congenital, and are much more common in the young than in the old. For the most part they are small-celled and very vascular. In a few cases they have been found to contain large quantities of fibrillated bundles arranged in different planes, crossing one another in all directions, and composed for the most part of striped muscular fibres.

**Symptoms.**—The signs of malignant disease of the kidney are, as a rule, very obscure, until it has reached an advanced stage and formed a definite tumor. Hæmaturia may be present, and when it is, it is generally profuse, but it may remain absent almost through the whole course. Pain is rarely wanting; usually there is a dull aching in the loin; and later, violent neuralgia shooting down the branches of the lumbar plexus; and sometimes there is intense irritability of the bladder. Contraction of the psoas muscle, leading to lameness and a suspicion of hip disease; jaundice, especially when the right side is concerned; œdema of the legs from obstruction to the circulation; constipation from pressure upon the colon, and vomiting, probably reflex in character, are not uncommon. The urine may show no sign; more frequently there is hæmaturia at one time or another: albumin is only present when there is blood, and renal colic may occur under the same conditions.

The question of operation under such circumstances is very doubtful. It rarely happens that a diagnosis can be made until the kidney is definitely enlarged, and then complete removal is almost hopeless. Sarcoma in children is probably the worst, and it is very rare to meet with a case in which nephrectomy is justifiable; in the case of adults, and with carcinoma, there is a little more hope; it is known that patients have lived for a considerable period without recurrence; but the operation cannot be recommended unless it is probable, from the duration of the case, that the disease is still limited to the kidney.

### Renal Calculus.

Renal calculus may occur at any period of life, but is most common at the two extremes; and it may be formed either of urate of ammonium, uric acid, oxalate, phosphate, or carbonate of lime, ammonio-magnesium phosphate, cystin, or xanthin. Of these the first is most common in infants; the next two during adult life; while the rest, especially the last two, are very rare. Not unfrequently the calculi are laminated, layers of different substances, more or less pure, alternating with each other, according to the reaction and character of the urine at the time.

Some are developed in the calyces, others in the epithelium of the urinary tubules. The former are composed of triple phosphate, and are either formed around blood-clots, or, in cases of pyelitis, as concretions on the roughened and

ulcerated surface of the mucous membrane when the urine becomes ammoniacal. The cause of the latter is more obscure. Some originate from the infarcts in the renal tubules of infants; and these, though they may be multiple, if once removed, never return; the condition which gives rise to them disappears as soon as the urinary secretion is well established. In the case of others, the fault appears to lie in the epithelial cells; their energy becomes impaired, whether from long-continued overwork, old age, or disease; they lose their power of discharging into the urinary tubules the materials withdrawn from the blood; and, as a result, these increase and accumulate until at length a nucleus is formed. It is probable that this only takes place when there is at the same time a morbid condition of the urinary passages leading to the production of a suitable colloid medium. There is evidence to show that when a material of this kind is present the urinary salts are precipitated, not as perfect crystals, but in a modified form, similar to the rounded masses that are found as nuclei; and it is certain that the mere increase in the amount of urinary salts is not a sufficient explanation. However this may be, these calculi differ in one very important respect from those that occur in infants: they are the result either of inheritance or of faulty modes of life, such as excess of nitrogenous food or of strong wines; and as the causes usually continue in activity after the calculus is removed, recurrence is not uncommon.

**Symptoms.**—Renal calculi may be small, round, and freely movable; encysted, so that they are practically fixed; or large, branching masses, reproducing somewhat the shape of the pelvis and calyces after the secreting part has been partially destroyed (Fig. 419). The general symptoms are the same in all, but they vary greatly in intensity. In every case the family and personal history should be thoroughly investigated; the tendency to the formation of calculi is undoubtedly inherited, and recurrence very common.

*Pain* is always present. Two chief varieties can be distinguished, though there is every intermediate gradation; one is dull, aching, and continuous, felt mainly in the loins, but radiating down the thigh, into the groin, and especially into the testicle. It is present in nearly all, and is especially severe after moving or jolting, as in riding, and after the pelvis has become inflamed. The other (*renal colic*) only occurs with small and movable calculi when they drop into the orifice of the ureter and throw its muscular fibres into a state of spasmodic contraction. It is usually brought on by some sudden movement; often it begins with a rigor, and it is of the most intense description, shooting down to the testicle, into the thigh, and, perhaps, over the whole of that side of the body. *Nausea* and *vomiting* generally occur at the same time; the patient rolls over and over with agony, lying curled up as much as possible to relax the muscles; the face is pale and shrunken; there is extreme collapse; the forehead is covered with perspiration; the skin is cold and clammy; and the pulse at the wrist can scarcely be felt. It is not continuous, but comes on in paroxysms, and may end quite suddenly; many patients never suffer from it at all; in others it returns again and again at intervals of a few weeks or months, each time causing fresh mischief in the kidney, until the calculus is either passed or becomes so large and so surrounded by inflammatory exudation that it can no longer occupy the narrow part of the pelvis. The same symptoms may be caused by the passage of blood clots, and even by hydatid cysts set free in the pelvis. In many cases the pain is referred to other parts of the body, especially to the genito-urinary tract and along the course of the lumbar and upper sacral roots. *Neuralgia of the testis* is of frequent occurrence; sometimes it is so tender that it can scarcely be touched; *irritability of the bladder* is often present, and may, as in strumous pyelitis, be exceedingly severe; sometimes there are *paroxysms of pain*, shooting down the foot or leg, similar to the lightning pains of locomotor ataxy; or a constant burning sensation in the heel; or intense sciatica. In fact, wherever paroxysmal pain occurs in the lower extremities, especially if it is attended by nausea and retching, or with any alteration in the condition of the urine, the possibility of renal calculus must always be borne in mind.

*Retraction of the testis* is very significant. When the calculus is in the ureter,

it is rarely absent, and the gland may be held tightly up against the abdominal ring. It is not so well marked or so constant while the stone occupies the pelvis.

*The examination of the urine* is most important. Blood is almost always present at one time or another, especially after exertion, and it is always evenly mixed with the urine. If the hemorrhage is recent, the color is bright red; if some time has passed, dark brown or smoky, or even almost black, like porter. The amount is rarely large, and coagula are not often met with, except after the spasm of renal colic; then the whole organ becomes tender and congested, and it may pour out in considerable quantity. In other cases large quantities of gravel or brick-red crystals of uric acid may be found from time to time. Mucus is always present and sometimes epithelium, which may be recognized as coming from the pelvis; so long as the urine is acid, the quantity may not be great, but in the more severe cases, where the calculus is large or irregular in shape, and especially where the urine has undergone decomposition, and suppurative pyelitis is present as well, the discharge is profuse and loaded with crystals of triple phosphate. When this occurs other symptoms soon follow; the temperature rises, especially in the evening, sometimes as much as two or three degrees; headache and drowsiness are of common occurrence; the appetite fails completely; the tongue is dry and cracked; nausea is almost constant; and the patient rapidly loses flesh and strength.

*Tenderness in the loins* and *rigidity of the muscles* are always present. If there is more than one calculus, grating can sometimes be made out by deep palpation when the patient is under an anæsthetic. Enlargement of the kidney is more common; sometimes it is real, due to congestion; but more often it is caused by condensation of the fibrous tissue around from continued irritation; and not uncommonly it is only apparent, the kidney being dragged downward by the spasmodic contraction of the muscular fibres of the ureter.

**Diagnosis.**—When there are repeated attacks of renal colic without the stone passing into the bladder, and apparently causeless vesical irritability, with the presence of blood and mucus in the urine, the diagnosis of renal calculus is easy. In many instances, however, it is a matter of the greatest difficulty. Nephralgia, closely resembling renal colic, may occur in delicate women, during the menstrual period, from the physiological enlargement of the kidney; it may be present with hæmaturia in chronic interstitial nephritis; biliary colic and duodenal inflammation may imitate it closely on the right side; while there are many cases on record in which there has been great difficulty in distinguishing it from vesical calculus, lumbago, typhlitis, and even aneurysm.

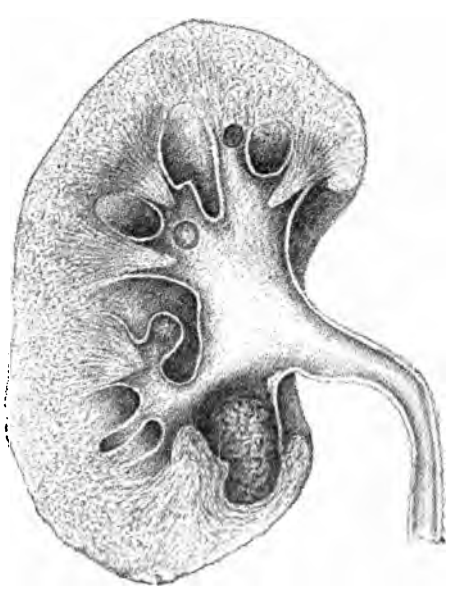


FIG. 418.—Calculus Encysted in Lower Part of Pelvis.

Cancer and tubercle affecting the kidney are the most difficult, particularly in the early stages; renal colic may occur in both, due either to coagula or to broken-down caseous masses traversing the ureter; lumbar pain, hæmaturia, and vesical irritability are usually present; and in many cases there is nothing distinctive in the urine. In malignant growths, however, the hemorrhage is usually profuse and is rather the cause of colic; while in tubercular pyelitis the amount of pus is always greater than in the case of calculus, unless this is complicated by the presence of alkaline urine and decomposition; and true renal never occurs until the caseous

have begun to undergo disintegration. Search should always be made for cancer cells and for tubercle bacilli; but unless the greatest precautions are taken they are very difficult of identification, especially the latter; and the fact of their not being found even after repeated examination cannot be regarded as evidence of their non-existence.

It is not uncommon for calculi to remain latent in the kidney for years without causing active mischief, and in many instances they have been found *post-mortem* without their presence having been suspected during life. In the majority, however, they give rise to symptoms of greater or less severity; and in a very large number they lead to such extensive destruction of the kidney, and such serious interference with health and strength, that the question of removal becomes imperative.

It is least serious when the calculus is encysted in one of the calyces or fixed between the pyramids (Fig. 418); the renal substance around becomes absorbed and indurated; a sac of dense fibrous tissue is formed; and the amount of inter-

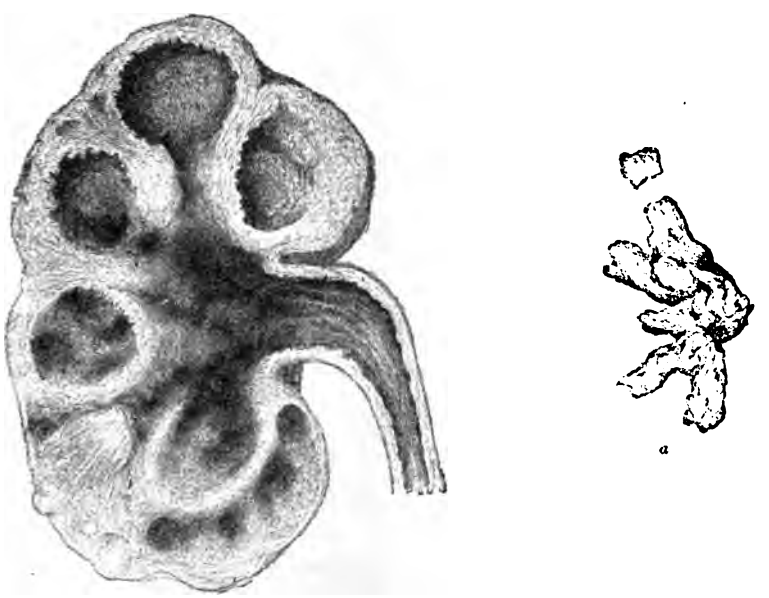



FIG. 419.—Suppurative Calculous Pyelitis with Destruction of Renal Tissue. (*a*) The Calculus Removed from its Bed.

stitial connective tissue throughout the organ is increased; but provided the size remains moderate, and suppuration does not set in, the stone may remain quiet and undisturbed for years.

Small calculi lying loose in the pelvis are infinitely worse. On the one hand they cause repeated attacks of renal colic, which end at length in hydronephrosis and interstitial nephritis; on the other, they set up acute inflammation of the pelvis, which spreads to the secreting tubules and finally destroys them. The mucous membrane first becomes irritated; then the apices of the pyramids disappear; the kidney substance is broken down and eaten away; and at length, partly by absorption and dilatation, partly by ulceration and sloughing (especially after the urine has begun to decompose), a large irregular cavity is formed, in the centre of which lies the calculus, grown perhaps into a branching mass which almost fills the interior. In extreme cases nothing is left but a shapeless bag of pus, formed by the capsule and the fibr[redacted] with perhaps some shreds of cortex, coated with [redacted] upon the inner surface (Fig. 419).

**Treatment.**—In *acute renal colic*, the pain and spasm must be relieved with as little delay as possible, in the hope that the calculus may reach the bladder; as soon as it leaves the ureter, the symptoms begin to subside. Opium is of the greatest value, and, if the kidneys are sound, must be given freely, either the tincture mixed with an equal quantity of water, so that the amount of fluid is small, or morphia, with a minute quantity of atropia, hypodermically. Chloroform is of use when the spasm is severe, but the inhalation should not be prolonged. The bowels should be emptied at once with a hot-water enema, not only because this prevents the pain caused by the pressure of a loaded colon, but because it relieves the spasm of the ureter, and by the effort at expulsion helps the passage of the calculus; the patient should be placed in a full-length hot bath (temperature 98° F. gradually raised to 101° or 102° F.) for twenty minutes to half an hour; and if this does not soon give relief, the loins should be dry-cupped on both sides. Hot distilled water, or very weak tea, or barley-water may be taken freely; there is no object in limiting the amount if the patient can take it, but not unfrequently it merely increases the sickness.

Generally speaking, after twenty-four hours the paroxysms become less severe; if the stone passes into the bladder, they stop suddenly; if it remains in the ureter, they continue longer, and cease very gradually, often returning again in a milder form with the least movement. In either case the patient is left in a state of extreme prostration, utterly worn out; and though the color may return, and the face resume its natural expression within a few hours, it is not unfrequently many days before the strength is regained and the patient is able to move about again without the dread of recurrence.

*Impaction in the Ureter.*—The calculus may be arrested at any point, but nearly always it is either at the commencement, where the pelvis narrows into the ureter, or at the end, so that it projects slightly into the bladder. In the latter case it can be felt as a round, hard mass, through the wall of the rectum or vagina. In women the bladder can be explored with the finger under an anæsthetic; but in men, unless the stone projects so far into the cavity that it can either be seen with the endoscope or felt with a sound, this help is lost.

The treatment must be guided by the symptoms, and particularly by the condition of the other kidney. If the amount of urine secreted does not fail, manipulation may be tried under an anæsthetic; copious hot enemata may be given with opiates and warm baths; and if the calculus can be felt near the end, an attempt may be made to hook it down further by means of the finger, or to extract it through a suprapubic or a perineal incision, making a small nick in the mucous membrane at the orifice if necessary. If the impaction is not relieved the symptoms become less urgent as time passes, the colic subsides, the kidney wastes, and hydronephrosis follows.

It is much more serious when the other kidney is already disabled, whether this arises from a similar accident (which is not at all uncommon), congenital defect, or disease; the secretion of urine is then arrested altogether, and unless relief is speedily obtained, the condition must prove fatal. The same measures may be tried first, but if they do not succeed, either an incision must be made in the loin to drain the kidney, or the abdomen must be opened and the ureter traced until the obstruction is found. If the calculus is felt, the peritoneum and the wall of the ureter may be incised, the stone removed, the cavity cleansed, the wound in the ureter stitched together again, and the peritoneum united over it; or, if the obstruction is due to any other cause, it may be dealt with according to circumstances. Which of these operations should be performed depends upon the condition of the patient. The latter is the more thorough, and as both ureters can be examined, there is less likelihood of an operation on the wrong side, but it is the more serious; the former, unless the calculus is lying in the pelvis within reach, can only be regarded as a temporary measure, leaving behind it a renal fistula in the loins, through which the whole of the urine must flow.

*In the Pelvis.*—A calculus in the pelvis may sometimes be so reduced in size

by solution or disintegration that it becomes small enough to pass through the ureter; or if this does not happen, it may work out a bed for itself, and become fixed by fibrous tissue, so as to give no further trouble. An operation should not be proposed until after the former of these, at least, has been tried.

*Solution* can only succeed with small calculi, composed of uric acid or urates; large ones are out of the question, and oxalate of lime, and substances deposited from alkaline urine are not sufficiently soluble. It is of most service where small masses of uric acid are constantly being formed in the urinary tubules, and dropped into the pelvis, as in the case of the pisiform concretions of old people, causing them to be dissolved and wasted away before they get too large, and acting rather as a preventive means; but even after being in the pelvis some time, calculi can be so reduced in size as to pass easily down the ureter, or at least give no further trouble. The citrate and bicarbonate of potash, which are often given in large doses for this purpose, are not of much service by themselves; the urine must be very concentrated for them to have any effect, and as the alkaline fluid simply passes over the surface of the calculus, the chance of any appreciable solution is exceedingly small. Moreover, there is the danger that, if large or long-continued doses are taken, the urine may become too alkaline, and deposit a layer of phosphates. Distilled or soft water, on the other hand, taken in large quantities, four to five pints a day, with occasional doses of citrate of potash, or of some alkaline water, such as that of Vichy or Contrexeville, is often most effectual. The specific gravity of the urine is diminished; the rate of secretion is increased; it acts to a slight extent as a solvent and, what is of more importance, by diminishing the amount of inorganic material, it assists the disintegration of the external laminæ; but for this to answer, the treatment must be continued for a considerable length of time, the urine must never be allowed to become concentrated, and the diet must be carefully restricted. Fish and white meat are to be preferred; sweet fruits, especially cooked sugar and rich pastry, should be avoided; bread should be toasted; and the amount and kind of alcohol carefully prescribed. Probably patients with renal calculi would be better without any; but in many instances they are so worn out by suffering that depriving them of it altogether would prevent their digesting anything else. Beer and strong wines, containing large quantities of sugar, are certainly injurious; but the lighter ones, or small quantities of spirits, well diluted, and taken with the meals, may generally be allowed.

[Poland Spring Water or Chippewa Spring Water, being pure, soft waters, free from mineral or saline constituents, have great usefulness.]

Small doses of turpentine, given either in the form of emulsion, or, better, in capsules, are of great use in these cases; not unfrequently a large amount of gravel is brought away in a very few days. Probably this is due to the effect that the turpentine has upon the lining membrane of the pelvis: the secretion of mucus is checked; the growth of the calculus is arrested; and the size of the passage through which it has to pass is materially increased by the diminution of the hyperæmia and swelling.

If these measures fail, and if there is either a small calculus constantly rolling about, or a large one gradually destroying the kidney, an attempt should be made to remove it by operation. In the one case it will, if left to itself, lead, after repeated attacks of renal colic, to interstitial nephritis and hydronephrosis, with, very possibly, if it occurs on both sides, suppression of urine; in the other it will end at length in septic decomposition and suppuration, which will spread from the pelvis to the kidney and destroy it.

## Inflammation of the Kidneys.

Inflammation of the kidneys may be either primary (nephritis) or secondary, due to extension from the pelvis (pyelonephritis).

1. ***Acute nephritis*** is not common, but it may be caused by exposure to cold

and wet, by extensive lesions of the cutaneous surface, and by irritating substances in the urine, such as cantharides or turpentine. Mild forms are occasionally met with in erysipelas and, very rarely, in secondary syphilis.

**Pathological Appearance.**—The kidney is swollen and rounded; the veins are prominently marked; the capsule strips off readily, and when it is cut open the surface is deeply congested; it may even drip with blood. In milder cases, where the symptoms have lasted longer, the cortex is paler, owing to the great increase in the epithelial elements in the tubules, and the contrast of the pyramids is still more marked.

**Symptoms.**—Acute nephritis may set in with a rigor. The temperature may reach 103° F. the first day; headache, vomiting, insomnia, and loss of appetite, are always present; the pain and aching over the loins never cease; often there is the most intense desire to micturate; the quantity of urine is greatly diminished; in severe cases there is almost complete suppression; the specific gravity is high; it is loaded with blood and casts; and it nearly always throws down a turbid deposit of urates, epithelium, and broken down corpuscles. If the inflammation is severe and the excretion of urine seriously checked, dropsy may set in within twenty-four hours; more frequently it does not appear until the second or third day. Sometimes there is only puffiness about the eyelids; sometimes, on the other hand, there is general anasarca, invading the serous cavities, and even causing death from œdema of the glottis.

**Treatment.**—The chief object is to reduce as far as possible the amount of work and to relieve the congestion. In mild cases it is sufficient to keep the patient warm in bed, at an even temperature, with the bowels relaxed and the diet restricted; in more severe ones great relief may be obtained by the use of hot-water and vapor baths. Cupping over the loins is often beneficial; and where the fever is high, and the patient young and vigorous, venesection may be performed with advantage. The bowels should be opened with castor oil, or a small dose of calomel, and then kept relaxed with sulphate of magnesia; it is doubtful if strong hydragogue purgatives do not do more harm than good. Nitrogenous food should be excluded from the diet, at any rate for the first few days; after that small quantities of milk may be allowed; but eggs, and other articles of food that consist largely of albumin, should be forbidden. As the symptoms subside, great care is necessary, both with regard to this and to the temperature; relapses very easily occur, and there is great danger, if the symptoms persist for any length of time, that the condition may become chronic.

2. *Chronic Nephritis.*—Chronic interstitial nephritis is much more common and is more important; on the one hand, it impairs general nutrition to such an extent that the tissues slough with the least injury; on the other hand, it so predisposes the kidneys to the influence of shock, that any operation upon the urinary organs is very liable to be followed by complete or partial suppression of urine.

It may follow an acute attack; or be caused by the same influences (such as cold, wet, exposure, or irritating conditions of the urine), acting with less intensity but greater persistence; or it may be the consequence of certain morbid conditions of the bladder or urethra.

One of these is an impediment to the outflow of urine. Whenever this occurs, whether it arises from stricture, enlargement of the prostate, or any other cause, tension is exerted on the part behind, and this leads to a certain degree of dilatation and chronic inflammation. Even undue frequency of micturition, such as is met with in vesical calculus, is sufficient.

This, however, is not the only one. Chronic inflammation (without dilatation) may be caused in an entirely different way. The passage of a catheter is followed, in many people, by sudden congestion of the kidneys; as a rule, this subsides of itself; but, if it is frequently repeated, or if there is a stricture in the deeper part of the urethra, causing a certain amount of spasm every time the urine passes over it; or a vesical calculus constantly falling against the neck of the

bladder; or, if the urethra is in a state of chronic inflammation from repeated attacks of gonorrhœa, this congestion practically becomes chronic; the connective tissue grows more dense and fibrous; the vitality of the epithelium is impaired, and the kidney becomes small, hard, and cirrhotic. It must remain, in most cases, uncertain how far this disease of the kidneys is the result of tension only, and how far it is due to the chronic congestion; but this is certain, that no condition of the bladder or urethra which interferes in any way with their proper function can exist for long without producing a most serious effect upon the kidneys.

The pathological appearances depend, to some extent, upon the degree of obstruction. The kidney is generally smaller than natural, hard, and dense; the surface is irregular; the capsule adherent, so that it tears away with it small portions of the tubules; the cortex thinned and wasted, with small cysts scattered through it, and the pyramids flattened and compressed. The pelvis may be normal, but, especially in those cases in which the interstitial growth is due to obstruction, it is dilated, and there may be every degree, from incipient fibroid change with slight expansion to extreme hydronephrosis, with nothing left of the kidney but a thickened disc of connective tissue.

**Symptoms.**—When fully developed, these are characteristic; in the early stages the patient seldom comes under notice. There is a slight but distinct failure of strength; the skin is dry and harsh, itching constantly; headaches are of common occurrence; occasionally there are attacks of vomiting; neuralgia is not infrequent, and is often very obstinate; the patient grows thin and pale, and sometimes hypochondriacal; there is loss of sexual power and very generally increased frequency of micturition, especially at night. The pulse is full and incompressible; the left ventricle is hypertrophied; there is a tendency to epistaxis, and other hemorrhages, and in the final stages a certain amount of œdema.

The urine is greatly increased in quantity, and its specific gravity is exceedingly low; the color is generally bright, and there is rarely much deposit, though a very few casts with some epithelial cells and crystals of oxalate of lime are occasionally to be found. Very often there is no albumin, but, as the disease advances, especially if the amount of urine begins to fail, it may make its appearance, though never in any large quantity.

Toward the end hemorrhages occur, in the retina among other places; visceral complications arise, and the patient may be carried off by pleurisy or pneumonia; œdema sets in; the vomiting becomes more frequent; muscular twitchings make their appearance and grow worse and worse, until, at length uræmic convulsions and coma end the scene.

**Treatment.**—The first thing is to remove the cause, whether it is stricture, calculus, or anything else. It is true that the risk of shock and suppression is very much greater than in ordinary circumstances, but waiting longer than is absolutely necessary to bring the patient into the best condition will not make it less. After this has been done, the kidneys must be saved as much as possible and protected from injurious influences. Iodide of potash and bichloride of mercury, in very small doses, may have some influence in checking the hyperæmia and assisting the absorption of the lymph, if given before the contraction is too dense, and in the later stages chloral allays the irritability of the skin, and checks muscular twitching. Most reliance, however, must be placed upon rest, warmth, and diet. During the subacute attacks that are frequently present, the patient should be confined to bed; exertion, both mental and bodily, should be avoided; long railway journeys are particularly injurious; the clothing should be warm; damp and chilly residences are especially injurious; the diet must be light but nutritious; alcohol should only be taken so far as is necessary for digestion; eggs and other substances that contain a large amount of albumin should be partaken of very sparingly; milk may be allowed freely, especially with farinaceous food and the lighter forms of meat; but great care should be taken not to overload the digestive organs, or to run the risk of causing dyspepsia.

### Pyelitis and Pyelonephritis.

Inflammation of the mucous membrane of the pelvis of the kidney is rarely met with by itself. Except in the mildest cases, such as those caused by the accumulation of gravel in gout, the kidney almost always becomes involved before the disease has lasted any length of time; and, in those in which suppuration breaks out, its whole substance may be destroyed, nothing being left but a sac distended with pus, with scarcely a trace of the original structure visible.

**Causes.**—These are almost the same as those of inflammation of the bladder. Cold is occasionally one. Injury is more common, whether it is mechanical, due to the irritation of a calculus, or chemical, arising from the action of noxious substances in the urine. Tubercle is not at all rare, while, in exceptional cases, new growths, carcinoma, and villous tumors similar to those in the bladder, have been the cause. Finally, it is often due to extension, especially from the ureters. At first, the inflammation is limited to the pelvis, but, if the cause is a large calculus with spreading branches, or if it is foul and septic urine, or if the deposit of tubercle, instead of being confined to the pelvis, is scattered through the substance of the organ, the kidney rapidly becomes involved as well, and in a very short time the whole of it is either riddled with minute abscesses, or converted into a suppurating sac. Sometimes the ureter is obstructed, so that the pus is unable to escape, and then a huge swelling, *pyonephrosis*, forms in the loins. In very rare cases the closure is incomplete, and there is an intermittent discharge of fluid, as occasionally happens with hydronephrosis.

**Pathological Appearances.**—These differ very considerably. *In simple catarrhal pyelitis*, the mucous membrane is swollen, thickened, and redder than natural; the surface is raw from the loss of its protecting epithelium, and in severe cases is coated over with lymph, mixed perhaps with blood. Sometimes there are older, darker extravasations, and, when the disease is of long standing, the color *post-mortem* may be almost black.

In *calculous pyelonephritis*, when the stone is the only cause, the mucous membrane may show no further change; or, if the irritation has been of long duration, the substance of the kidney may be eaten away—the medulla especially having suffered—and the interstitial connective tissue thickened and hardened. Unfortunately in most cases the urine decomposes and suppurative pyelonephritis makes its appearance in addition. When this occurs, the mucous lining becomes thickened, ulcerated, and coated with a slimy deposit of pus and phosphates; the whole of the medulla and most of the cortex are eaten away, and nothing is left but a large irregular cavity full of foul and decomposing pus, with roughened and rugged walls lined with the debris of the broken-down and ulcerated cortex (Fig. 419).

*Tubercular pyelonephritis* may occur in the course of general miliary tuberculosis, or at first, at least, as a local affection. In the latter case it may begin in the bladder or in the kidney; but often before the disease has lasted any length of time, it extends from one to the other, and not infrequently involves both the kidneys, although in different degrees. In the earlier stages the mucous membrane of the pelvis is thick and soft, and the surface like sodden wash-leather: here and there are small superficial ulcers with sloughing and ragged edges, due to the breaking down of the caseous deposit; the pelvis is enlarged owing to increased difficulty in the discharge of the urine; and according to the situation of the growth, there are either numerous small caseous foci in the substance of the kidney, or the apices of the pyramids are eaten away. When the disease is of longer standing, the tissue around the kidney is condensed and indurated; the capsule is thickened and cannot be separated from the cortex; the medulla is almost destroyed, and the cortical part is softened and disintegrated (Fig. 420). Ultimately suppuration occurs, as in other forms of advanced pyelitis, and the whole of the renal substance may disappear and nothing be left but a thickened shell of fibrous tissue, preserving somewhat the shape of the kidney, filled with a slimy mass of tenacious pus, like soft putty.

*Suppurative pyelonephritis* (surgical kidney so-called) such as is met with in old cases of stricture, vesical calculus, or enlargement of the prostate, after ammoniacal decomposition of the urine has set in, has already been mentioned. The kidney is generally small, hard, contracted and granular from the pre-existing interstitial nephritis; minute abscesses, each surrounded by its zone of congestion, are present in numbers under the capsule, or buried in the cortex, or extending as long, slender streaks in the substance of the pyramids; here and there between them are points where the inflammation has not yet culminated in suppuration; the apices of the pyramids are eaten away; the pelvis and calyces are irregularly dilated from the old standing obstruction; and the mucous membrane is discolored, ulcerated, coated over with stinking pus, and even sloughing. Decomposition has occurred in the bladder and caused acute cystitis; and the poison has spread directly upward to the pelvis and into the substance of the kidney. Very rarely the pelvis is healthy, in spite of the presence of advanced nephritis, the germs having, in all probability, gained the kidney by spreading along the lymphatics of the ureter and the capsule, until at length they reach the interstitial spaces that lie between the tubules and surround the glomeruli.

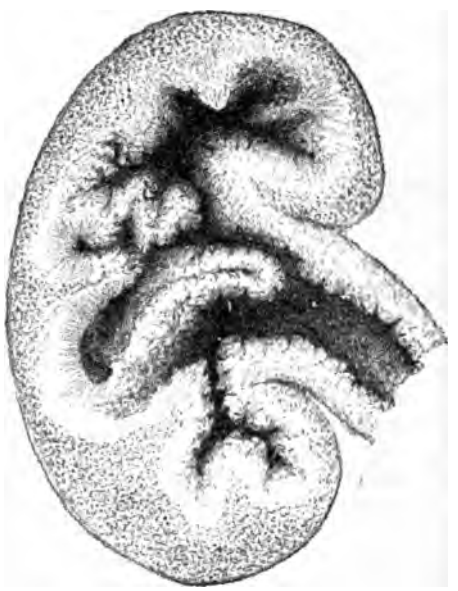


FIG. 420.—Tuberculous Pyelonephritis.

**Symptoms.**—Pyelitis may affect one or both kidneys, according to the cause. When it is due to septic urine and cystitis, it is nearly always bilateral; the tubercular form may begin in one, but very often it extends to the other at an early period; and though the retention of calculi in the pelvis is in some measure the result of accident, their formation is due to constitutional causes, and if they are present on one side there is very great probability of their occurrence on the other.

*Local.*—In the early stages the symptoms of pyelitis are very indefinite, unless the attack is acute, or there is a small calculus dropping constantly into the orifice of the ureter; in the chronic forms, at the commencement of tubercular disease for example, they may be entirely wanting. As the inflammation spreads and involves the kidney, there is a constant dull aching in the loins; the muscles are rigid and tender; there is stiffness on moving, and not unfrequently either diarrhœa or constipation. In the later stages of calculus and tubercular disease, when the tissues around are involved as well, the pain may be exceedingly severe, and the kidney may feel as if it were enlarged; but there is rarely any distinct swelling unless the ureter is closed and pyonephrosis has set in.

Neuralgia radiating down some or all the branches of the lumbar plexus, into the groin, down the inner side of the thigh, or into the testicle, is always present, and is often severe when there is a calculus. Irritability of the bladder is almost as general; in renal tuberculosis it is one of the earliest signs, and it is not uncommon for the bladder to be sounded time after time for stone, especially in children, before the real cause is detected. In the later stages it may be simply agonizing.

The character of the urine is most important. In simple catarrhal pyelitis it is acid, and varies but little in quantity or specific gravity; but it is turbid, and

yields on standing a sediment, in which the characteristic spindle-shaped or caudate cells of the pelvis can be detected. Blood-corpuscles are generally present if there is a calculus, but in the other forms they often do not appear until later. As the case progresses the epithelium disappears, the amount of mucus increases; and this in its turn is replaced by pus, which may be present in such quantity as to form a thick creamy deposit at the bottom of the vessel.

In tubercular and calculous pyelitis, the urine may continue acid quite to the end, in spite of the amount of pus that is added; in the septic form, on the other hand, it is alkaline and ammoniacal, and the pus, mixed with phosphates, forms a dense, viscid, gelatinous mass, similar to that secreted by the bladder under the same conditions.

*Constitutional.*—These depend partly upon the amount of suppuration, partly upon the extent to which the renal substance is involved, and whether both kidneys are implicated or only one.

In the so-called surgical kidney, consequent upon vesical disease, the symptoms are essentially those of chronic nephritis, with partial and increasing suppression. There is rapid emaciation, with loss of strength, dryness of the skin, headache, neuralgic pains and vomiting. The pulse is small, quick, and feeble; the temperature rises to 102 F. or 103° F.; rigors occasionally occur; and the patient gradually passes into a dreamy state, with low muttering delirium, until diarrhœa with a subnormal temperature, or coma, and perhaps at length convulsions, follow.

In tubercular and calculous pyelonephritis, if only one kidney is affected, the other may become hypertrophied, and, so far as the urinary secretion is concerned, compensate perfectly; and sometimes when this occurs the pus dries up (especially if the ureter becomes blocked), and the kidney is at length converted into a pasty, mortary, or even calcareous mass, surrounded by a fibrous capsule. Much more often, however, suppuration sets in, and symptoms similar to those present in any case of ill-drained abscess make their appearance; the temperature rises, especially toward evening, or rigors occur; the patient becomes weak and feeble; night-sweats and diarrhœa begin; and either hectic or amyloid disease, which is especially serious when there is only one kidney active, follows.

If both kidneys are affected, not only are these symptoms greatly intensified, but in addition the amount of urea and the specific gravity of the urine fall lower and lower until at length it ends in suppression.

**Diagnosis.**—The diagnosis of pyelitis at its commencement is often very difficult, and rests chiefly upon the irritability of the bladder, for which no cause can be found, the shape of the epithelial cells in the sediment, the amount of mucus in the urine, and the character and locality of the pain. When cystitis is present as well, as it not unfrequently is in gout and tubercle, the difficulty is greater still. In older cases, when the kidney becomes involved, there is little or no trouble; either the urine continues acid, in spite of its containing an enormous amount of pus, or, if it becomes alkaline and ammoniacal, the diminution in the amount of urea, the low specific gravity, the emaciation, and the other constitutional signs, render it clear that the disease, though it may affect the bladder, is not confined to it.

Calculous pyelitis may generally be distinguished from the others, by the severity of the pain, the way in which it radiates down to the testicle, the occurrence of renal colic, the effect of exertion, and the presence of blood-corpuscles in the urine at a very early period. When the inflammation is due to gravel, genuine colic is rare, though there may be a great deal of pain; and the urine is of high specific gravity, very acid and loaded with crystals. In either case, the history, the other constitutional symptoms, and the occurrence of previous attacks, are of great importance.

Tuberculous pyelitis is more difficult to distinguish, especially at the beginning, for though caseous masses and bacilli may be found in the urine when the disease is advanced, they are seldom present until the kidney itself begins to break

down. Very often the diagnosis has to be made by a process of exclusion; there is great irritability of the bladder, without anything local to account for it; the amount of mucus in the urine is undoubtedly excessive; blood is seldom present; the pain is not severe; there is no renal colic; and the urine does not contain either uric acid or oxalate of lime in excess. In these circumstances, the presence of tubercle elsewhere, especially in connection with the genito-urinary organs, must be regarded as of the gravest significance. Later, the amount of pus, the presence of caseous masses and of bacilli, and the acid reaction of the urine, are distinctive; but this does not prove that both kidneys are not involved.

Pyonephrosis can only be distinguished from hydronephrosis, of which it is not an infrequent termination, by the pain, fever, and rigors, which occur with more or less severity. In the case of perinephritic abscess, the shape and the outline of the swelling are not so distinct; and the urine is not affected. Other abscesses in the same region, due to disease of the vertebræ, cæcum, or liver, or even to an empyema working its way down, rarely present any difficulty.

In a very few cases the discharge of pus is intermittent, and there is a proportionate variation in the size of the tumor.

**Treatment.**—The treatment of calculous pyelitis and of that which is due to the presence of uric acid has been described already. If there is a stone, an attempt must be made either to procure its disintegration or to fix it in some outlying part; if this fails, and it continues to give inconvenience, it should be removed by operation, and afterward the diet and mode of life regulated, so as to prevent concentration of urine and the accumulation of uric acid.

When the pyelitis is due to decomposition of urine in the bladder, the growth of the ferment must be stopped by antiseptics and drainage. Meantime, every attempt must be made to restore the acidity of the urine, as this is a serious hindrance to the micrococcus, and to spare the kidneys as much as possible and economize the patient's strength by careful dieting and attention to the action of the skin and bowels.

The treatment of tuberculous pyelonephritis depends upon whether it is merely part of a general tuberculosis, or of an affection of the whole urinary system; or whether it is a local disorder, and still confined to one kidney. In the former case only palliative treatment is available; the strength must be maintained; the intense vesical irritation must be relieved by morphia; and any symptoms that arise must be met by suitable measures. Median cystotomy and drainage, which are of such service when the strangury is due to local causes, such as malignant disease of the bladder, are useless, when it is dependent upon the reflex action of the nervous system.

There is more hope when it can be shown that the affection is limited to one kidney, as it is in about half the cases, though it is very difficult to prove. The specific gravity of the urine may be good; the amount of urea may not be below the normal; and there may be an entire absence of pain on the opposite side of the body; but, unless the urine can be collected from the ureters separately, in sufficient quantity to be examined, it is not possible to be certain. In some of these cases the pus gradually dries up, the ureter having been accidentally blocked in some way; for it is not uncommon, *post-mortem*, to find kidneys consisting of nothing but a capsule full of calcareous or cheesy, mortary substance, years after all symptoms have subsided. This, however, cannot be relied upon; the disease is much more likely to prove fatal by involving the ureter or other organs near, from general miliary tuberculosis, or after prolonged suffering, from hectic and exhaustion. Whether nephrotomy and drainage, or nephrectomy and removal of the whole mass, afford the best prospect of relief, depends upon the circumstances of each case. If the patient is too exhausted to withstand the shock of the major operation (and it often happens, from the dense adhesions between the capsule and the surrounding structures, that a very long time is required for complete enucleation), or if there is any doubt as to the condition of the opposite one, nephrotomy is the more suitable. If there is any need for it, the shriveled and

contracted sac can be removed afterward. Where, on the other hand, there is nothing left but a fibrous sac without, when it is laid open, any trace of secreting structure, and where the adhesions can be broken down without unduly prolonging the operation, there is no object in leaving it to be completed at a later date.

### PERINEPHRITIS.

Inflammation of the cellular tissue around the kidney is occasionally primary, caused by injury or exposure to cold; much more frequently it is consecutive to disease elsewhere. Sometimes, as in calculous and tubercular nephritis, it arises by direct extension from the kidney, the pus gradually making its way through the capsule, and bursting, perhaps externally, so that the stone is discharged through an opening in the loins; sometimes it originates from inflammation about other structures near—the colon, cæcum, liver, or even the vertebræ. In a large number of cases it is due to the inflammation of the pelvic cellular tissue extending upward, after wounds of the lower part of the vagina or uterus; after childbirth, or after operations upon the testicle, spermatic cord, or rectum; and, finally, it may be pyæmic in character, following one of the acute exanthemata.

Perinephritis is sometimes chronic, the capsule and the cellular tissue becoming thicker and denser, until the kidney is invested in a dense fibrous wall which cuts and feels like cartilage; but, as a rule, suppuration soon sets in, and a large irregular abscess forms around the kidney, and spreads upward and downward as far as the yielding character of the tissues will allow. The kidney itself, unless the suppuration originated in it, usually shows no change; but, occasionally, the cortex is softened, in a state of cloudy swelling, and even filled with minute abscesses. Both sides may be involved, especially when it is the result of pyæmia.

**Symptoms.**—The early ones are very perplexing; very often there is a rigor at first, with constant vomiting; the temperature is very irregular; the bowels are obstinately constipated; there is a dull aching pain across the back, and the patient feels perfectly crippled. The body is inclined toward the affected side, and slightly bent forward; the thigh is flexed upon the abdomen, and the leg is rotated outward, as in the second stage of hip disease. The least movement makes the pain tenfold worse, and causes it to radiate down the lumbar plexus, but especially into the groin and the testicle; and with all this, the urine is either perfectly normal (unless, of course, there is calculous pyelitis), or, in some exceptional instances, contains a certain amount of albumin and a few tube-casts. After a time, the tenderness in the loin becomes more localized; there is a sense of deep resistance on palpation; and the skin becomes shining and œdematous, or even reddened, though fluctuation is seldom to be felt, even when the abscess contains several pints of fluid. If the case is left, and the constitutional disturbance does not prove fatal, the abscess either points over the crest of the ilium, between the obliquus externus and latissimus dorsi, or else extends under Poupart's ligament into the thigh. In a few rare cases it has been known to burst into the lungs (so that an enormous amount of pus was suddenly coughed up), the intestines, the peritoneal cavity, or even the ischio-rectal fossa.

**Diagnosis.**—Perinephritis and perinephritic abscess are usually much more acute than hydronephrosis, pyonephrosis, and the other diseases that cause enlargement of the kidney, and are not so sharply defined in outline. At first there may be some difficulty in distinguishing it from perityphlitis, and even from enteric fever; and it has been confused with hip disease (owing to the position of the limb), with caries of the spine, lumbago, fæcal accumulations in the colon, and with abscesses resulting from disease of other neighboring structures.

**Treatment.**—When the attack is subacute, an attempt may be made, by applying leeches and poultices, and by keeping the patient at rest, to procure resolution, but the result is rarely satisfactory. As a rule, rigors occur early, and mark the beginning of suppuration. The bowels should be well cleared out; hot water enemata are often of some relief; the pain should be controlled by opium

and belladonna; and as soon as suppuration is suspected, an exploratory puncture should be made with an aspirating needle. In a very few instances, if the abscess is emptied in this way, recovery takes place without incision; as a rule, it is necessary to open it freely, wherever it is most prominent, and insert a large drainage tube.

### URINARY FISTULA.

Fistulous channels discharging urine, pus, or both together, are sometimes formed in connection with the kidney, its pelvis, or the ureter; and they may discharge either externally in the loin; or on the front wall of the abdomen in the inguinal region; or into one of the neighboring viscera, the uterus or vagina most commonly, the stomach, intestine, and pleura very rarely.

The most frequent cause is calculous pyelitis leading to suppuration outside the kidney; after the abscess had been opened the passage contracts down to a sinus, the walls of which are lined with a kind of granulation tissue, and perhaps coated over with phosphates. It may result, however, from gunshot wounds or other injuries, from operations about the female pelvic organs, especially hysterectomy, and occasionally, from tubercle. In some cases, as in cystic disease of the kidney, and hydronephrosis, a urinary fistula is formed as a temporary expedient, where it is not possible to obtain at the time exact information as to the condition of the opposite organ.

After nephrotomy or nephrolithotomy, where the kidney is healthy and there is no obstruction in the ureter, the wound, though it may continue to discharge urine for a week or two, usually closes of itself. If it persists injections of iodine may be tried, or nitrate of silver fused upon a probe, or even a heated wire. When, however, in addition to the urine, there is a profuse discharge of pus, so that it is certain that the kidney is extensively disorganized, and there is fear of amyloid degeneration, or where the fistula is a source of intense annoyance and distress, and it can be proved that the opposite kidney is sound and not the seat of calculous disease, the best plan is to perform nephrectomy.

It must not be forgotten that fistulæ connected with the bladder and the urethra have been known to open in the inguinal region and even in the loin. In case of doubt the diagnosis can always be confirmed by the injection of milk or other colored fluids into the bladder.

### METHODS FOR DISTINGUISHING THE SECRETION OF THE TWO KIDNEYS.

In all operations about the kidneys, but especially when nephrectomy is contemplated, it is of great importance to obtain definite information with regard to the secreting power of each of them. As already mentioned, it is not uncommon to find that, as a result of congenital defect, accident, or disease, one kidney is either actually non-existent or else is so small as to be practically useless. Even in the abdominal operation this is not unnecessary, for all that can be ascertained by this is the size of the organ in question; it tells next to nothing about its condition.

Various methods have been devised, but none is satisfactory. The simplest is that suggested by Polk: one of the ureters is compressed just before its termination, between a piece of block tin, shaped like a catheter with a very sharp curve, introduced into the bladder, and two fingers placed in the rectum; or, if it is preferred, a curved spatula with a suitable groove on its upper surface. As soon as this is secured in position the bladder is washed out, and the urine from the other ureter allowed to collect, but it is very difficult to obtain more than half an ounce in an hour.

Catheterization of the ureters can be managed in women either with the aid of the electric light, or, the patient being in the lithotomy position, by placing the fore and middle fingers of the left hand in the vagina, one on either side of the os uteri, to which the orifices of the ureters nearly correspond, and, with these

as a guide, manipulating the catheter with the other. On one occasion I slit up the urethra so as to expose the orifices more thoroughly. If catgut sutures are used, no incontinence should follow. Even in women, however, this will not always succeed, and in men it is out of the question.

The left ureter may be compressed at the brim of the pelvis by means of Davy's lever introduced into the rectum; the right cannot, unless there is a meso-rectum. Even when used for a short time, however, this is not without risk; very serious bruising of the mucous membrane has occurred, although it was not possible to assert that too much force had been used; and certainly it would not be advisable to keep up a sufficient degree of pressure for an hour. The same may be said of the various attempts that have been made to secure the orifices of the ureters either by clamps shaped like a lithotrite introduced into the bladder, or by suction applied to the orifices of the ureters; they have only met with very partial success. When there is renal hæmaturia, the cystoscope is of some service; the jet of blood-stained urine may be seen emerging from the orifice of one of the ureters, but, unfortunately, it does not seem probable that this will be of much avail in the class of cases that need it most.

## OPERATIONS UPON THE KIDNEY.

### Puncture of the Kidney.

The chief use of this is for diagnosis; it may, however, be required either as a palliative or as a permanent measure in cystic disease, hydatid cysts, and even in cases of hydronephrosis. The aspirator should be introduced into the most prominent portion of the swelling, where the fluid seems to lie nearest the surface, taking care to ascertain the position of the colon first by inflation, if necessary.

### Nephrotomy.

Incision of the kidney may be required for suppuration, consequent on calculous or tuberculous disease (usually as a preliminary to further measures); for renal retention (when the ureter is blocked); or for hydronephrosis. In many of these cases puncture will have been performed first, and the more severe and radical measure is only adopted either because the milder plan has failed (perhaps in spite of repetition) or because the condition it has revealed is such as to require more active treatmeut. An operation of a closely similar character is necessary in cases of perinephritic suppuration.

The incision is always lumbar, and usually oblique, parallel to the last rib, and an inch below it. The skin, superficial structures, muscles, and aponeurosis are divided, as in colotomy, and the kidney exposed. If it is distended into a sac this should be opened either with a director and sinus forceps, or with a scalpel, according to the condition found, and after the contents have escaped, the space left should be explored with the finger to ascertain if there is any persisting cause, and drained. If, on the other hand, it is a case of renal retention, the cortex (which is always hard and congested) or the pelvis must be opened sufficiently freely to allow the urine to escape.

### Nephrolithotomy.

There are two methods of approaching the kidney for this purpose, either from behind in the lumbar region, or through the abdomen. That the former is the more suitable in cases in which the symptoms are definite and pointed plainly to one side, there can be no doubt, but it is still an open question whether abdominal exploration is not advisable in some as a preliminary. A certain amount of information can be obtained as to the condition of the opposite kidney; the posi-

tion of the stone, whether it is in the ureter or not, may be ascertained; and there is less risk of an operation on the wrong side. Moreover, it is possible when operating through the loin to be misled by the presence of a perinephritic abscess, the interior of which is often divided into chambers like a sacculated kidney; and it has happened before now, in the case of a very large and somewhat diseased kidney, that the finger has never entered the pelvis at all, but detached the thickened mucous membrane from the pyramids until a cavity was made closely resembling the true pelvis. As, however, a calculus cannot always be felt after the kidney has been removed, even the combined abdominal and lumbar method does not ensure perfect certainty.

The patient lies upon the opposite side with a firm cushion under the flank. The kidney is supported from the front and pressed into the loin by an assistant; but if the walls of the abdomen are rigid and dense with a thick layer of fat, it answers better, as soon as the kidney is exposed, to roll the patient nearly on to his back again, so that the convex surface may drop of itself upon the finger. An oblique incision, four inches long, parallel to and an inch below the margin of the last rib, is the most convenient. It should commence at the outer edge of the erector spinæ, and should not come closer to the rib for fear of wounding the pleura, which sometimes descends as low as this. The superficial muscles are divided, the lumbar aponeurosis, which here is very thick, cut through upon a director, additional space being obtained, if necessary, by section of part of the quadratus lumborum, and the circumrenal fat exposed. Any point that bleeds should be tied at once, but generally there is nothing that requires it.

As a rule, the tissue around the kidney is so loose and soft that it can be separated easily with the finger and a pair of forceps; sometimes, however, when there has been much inflammation, it is tougher; and in old cases of suppurative pyelitis it may be exceedingly dense. As soon as the convex surface is exposed, the kidney must be thoroughly and systematically explored, first on the outside, passing the finger over the anterior surface and hooking it forward into the wound until the pelvis is reached; then, as far as possible on the posterior, the fore and middle fingers passing behind it, while the thumb rests on it in front until it is fairly grasped. If nothing is detected in this way, no irregularity of surface or sense of resistance, the next step is to explore the substance of the kidney with a short stout needle set in a handle. It should not be more than two and a half inches long, for fear of wounding the vessels at the hilum. A number of punctures are made with this all over the cortex, always pointing in the direction of the pelvis. Sometimes a calculus is struck at once, but, especially when it is small, and it is often no larger than a pea, such good fortune is exceptional. If it is felt, the needle is used as a director; an incision is made by the side of it with a sharp scalpel, and a pair of long forceps, like polypus forceps, passed along it until the blades are in a position to grasp the stone.

Where this does not succeed, the pelvis should be explored with a sound similar to that used for a child's bladder, but with a shorter beak. It is passed through the cortex into the lowest part of the cavity, and the whole interior and all the calcyces systematically examined, the sound being carried at once to the upper end, a distance of nearly four inches, and working gradually down. Finally, if this fails, the finger must be used in the same way, introducing it through the same opening, and gradually dilating and tearing the kidney substance. The bleeding at the moment is tolerably free, but the pressure of the finger soon arrests it.

With a large branching calculus there is rarely any difficulty; when it is small, detection is often impossible. On one occasion I felt a small movable stone distinctly with the needle, but was quite unable to detect it afterward with the sound, forceps, or finger. Another case is recorded in which the kidney was excised, and afterward a stone was found in it, so buried that it could not be felt from the exterior, even after the organ has been removed. In a third case the calculus is reported to have come away subsequently in the dressings: and there is

a very large number on record in which no trace of a calculus was found. Fortunately the operation is one that, so long as the stone is small, is very rarely followed by serious consequences; and in most cases, even when nothing has been found, the relief has been complete, probably from the calculus becoming fixed in the substance of the kidney by inflammatory adhesions or cicatricial tissue.

Great care should be taken to extract the stone without breaking it, and, especially in the case of large ones with long slender branches, this may be a matter of some difficulty; and after this is done the interior of the cavity must be thoroughly explored to see that nothing is left.

The treatment of the wound is very simple. A large drainage tube should be passed into the kidney, so as to carry away at once all the urine that is secreted. and the fascia lumborum sutured with catgut, leaving only an orifice at the posterior angle for the drainage tube. Usually the wound heals without suppuration. The tube should be removed the next day to clear it of any coagula, and introduced again down to the surface of the kidney; the third or fourth day it may be shortened so as to project only through the opening in the fascia. The urine passed by the bladder generally contains a large amount of blood for the first two days, then it should become clear. Retention is common at first, and may continue so long as the tube is in contact with the kidney. A urinary fistula persists for a week or two in the loin; but if the kidney was healthy and the ureter is not blocked, it generally closes of itself.

In cases of calculous pyonephrosis, when there is a large tumor in the loin, and the urine is loaded with pus, nephrotomy or nephrolithotomy should be adopted in preference to nephrectomy. It is true that the statistics of the latter operation under these conditions are more favorable, but, as Brodeur has pointed out, it is almost impossible to form a definite opinion as to the condition, or even the existence of the opposite kidney. Later, when the patient has rallied, and it is clear from the amount and specific gravity of the urine secreted, that the power of the other kidney is not impaired, this operation may be performed, if the fistula persists and gives much inconvenience, or if the discharge of pus is at all considerable. With only one kidney active, there is naturally greater risk if there is any amyloid change.

It must always be recollected that, particularly in the case of adults, nephrolithotomy can only be looked upon as giving temporary relief. The tendency to the formation of calculi is there still, and the same precautions as to diet and regimen must be taken after the calculus has been removed, for fear of recurrence.

## Nephrectomy.

Excision of the kidney may be required for persistent hemorrhage following injury; suppurative pyelitis (whether calculous or tubercular) in which the renal tissue is hopelessly destroyed and the disease limited to one side; sarcoma or carcinoma: and, as a sequel to nephrotomy when (the other kidney being sound) a fistulous channel is left.

It may be performed either through the loin or the abdomen.

1. *Lumbar Nephrectomy.*—Morris recommends an oblique incision parallel to the last rib, with, if more space is required for dealing with the pedicle, a vertical one running down from it, just in front of its posterior extremity. The further steps of the operation are the same as in nephrolithotomy until the surface is exposed. As soon as this is reached, it must be freed from the tissues around. In some cases there are no adhesions; in others they are so dense that it is impossible to divide them without using scissors. Occasionally it is better to open the capsule, and try to shell the kidney out from it.

The next step is to secure the pedicle. It may be possible to draw the kidney so far out that the ureter can be isolated and a ligature passed round the vessels with ease. (Greig Smith recommends that, if this is done, all traction should be taken off before the knot is tied, for fear of the artery slipping back). In other

cases there is the greatest difficulty, and the mass must be secured with a clamp, or with an écraseur, and cut away piecemeal before the deeper structures are sufficiently exposed. The artery and vein may be tied in one (if an abnormal branch is detected it should be dealt with by itself), and as soon as the surgeon has satisfied himself that the ligature is safe, the kidney tissue or the pelvis divided at a sufficient distance and the rest of the mass removed. The ureter should be brought out at the lower angle of the wound, and fixed by a suture to the skin. In some cases the ligature has been placed almost on the side of the vena cava, but where it is possible a sufficient length of vessel should be left between. Finally the wound must be thoroughly dried, the peritoneum examined to see that it has not been rent, and a large drainage tube inserted.

[When oozing persists, or indeed as a routine procedure, it is well to pack the wound with iodoform gauze.]

2. *Abdominal Nephrectomy.*—The incision is made through the corresponding linea semilunaris (after Langenbeck's method), and the peritoneal cavity opened sufficiently to introduce the hand. The intestines are held on one side with sponges, and the condition of the opposite kidney ascertained as far as possible.

The posterior layer of parietal peritoneum must be divided on the outer side of the colon (so as to avoid injuring its vessels) and the surface of the kidney exposed and freed from its surroundings. As soon as everything is clear (the assistant holding up the torn edges of the peritoneum, and at the same time depressing the margins of the abdominal wound) the vessels are isolated and a ligature (double if possible) passed round them and tied. The separation is then completed and the mass removed.

The cut edges of the ureter may be inverted and stitched over, so that the stump may be left secure; or, if it is full of putrid pus or tubercular material, it may be pushed out through an opening in the loin and fastened to the skin. The plan of securing it in the anterior wound is objectionable, as tending to disturb the relation of the peritoneum.

The cavity left behind the peritoneum must be thoroughly cleansed, the flaps that have been detached pressed back into it (they need not be fastened with any stitches), and then the abdominal wound dealt with.

The relative merits of these operations are very differently appreciated. There is no doubt that in the case of very large masses the abdominal operation is the easier of the two (although if it is cystic, the size may be considerably reduced by tapping); that the pedicle is more accessible, and that a certain (very small) amount of information about the condition of the other kidney may be obtained. Further, if the nature of the tumor is doubtful, there is very much greater liberty of action. On the other hand, the peritoneal cavity is always opened; the colon is endangered; the ureter is difficult to deal with; if the operation is performed for suppurative or tubercular pyelitis, there is considerable danger of infecting the peritoneum, and drainage is almost out of the question.

## SURGICAL ASPECT OF THE URINE.

Examination of the urine is essential, not only for diagnosis in diseases of the urinary organs, but to obtain some idea concerning the activity of the metabolism of the body and the secreting power of the kidneys Except in emergency, no operation should be performed without this having been considered; it influences the prognosis more than anything else, especially when the urinary tract itself is concerned.

### 1. Quantity.

The amount passed during twenty-four hours must be ascertained in order to form an idea as to the reaction and the proportion of solids. It is sufficient in most cases to take the last two figures of the specific gravity and double them, or, if the urine is concentrated, multiply them by 2.33. This gives roughly in

grammes, the total solids for 1000 c.c. of urine, and if it is collected for twenty-four hours the rest is easy. Important constituents must be estimated separately.

When a patient is confined to bed the amount of urine (as regards both solids and liquid) is always diminished, so long as there is no fever.

The quantity may be lessened by general causes, such as fevers, profuse sweating, diarrhœa, etc.; or from local ones affecting the circulation of the kidney, or its secreting power, or both together. Acute nephritis, for example; congestion from cardiac disease: vasomotor disturbance excited reflexly by irritation of the urethra, especially if the kidneys are diseased already; interstitial nephritis and amyloid and fatty degeneration in their later stages; hysteria even occasionally; and shock, as after railway accidents, are all attended by diminished secretion. Sometimes the difference is only slight; in the worst cases there is complete suppression: no urine is passed for days. When one ureter is blocked there is rarely much difference in the quantity, even at the first, owing to the increased activity of the remaining kidney: but when both are affected, as when there is an insurmountable obstacle to the exit of the urine, suppression must occur.

In diabetes there is a great increase both in the amount of solids and of liquid; in hysteria and simple polyuria, due to lesions of the nervous system, only the latter. In contracted granular kidney, cystic degeneration and the early stages of amyloid disease, there may be a noticeable increase in the amount, but at the same time the specific gravity is diminished so that the total solids may fall far below the normal. In the matter of prognosis this is scarcely less important than the presence of albumin; the drain upon the strength may be less severe, the loss of color and condition less marked, than when there is a constant daily waste of nitrogen; but the elimination of effete products is often very much more defective.

### 2. Color.

This depends partly upon concentration, partly upon the addition of foreign substances, such as blood, bile, melanin, and, under certain conditions, indican. Carbolic acid, when present in the blood in excess, gives the urine a peculiar dark-green smoky tint, which, if it is allowed to stand for some time, may become almost black.

### 3. Odor.

In chronic cystitis the urine is often offensive, even fæcal; or it may be ammoniacal from decomposition. Characteristic odors are produced by turpentine and other drugs.

### 4. Reaction.

Normal urine is acid, and this becomes more marked during the first few hours, if it is allowed to stand in a clean vessel. Concentration, an excessive amount of nitrogenous food, and diminution in the quantity of alkaline phosphates, a condition frequently found in ill-nourished strumous children, increase the acidity. Associated with this is a peculiar train of symptoms, such as are common in gouty patients; the bladder is irritable, there are frequent attacks of dyspepsia, neuralgia, cramp, and palpitation; irritability of the skin is not uncommon; sometimes eczema and psoriasis occur; gravel is present from time to time, and slight attacks of synovitis are of frequent occurrence.

On the other hand, urine may be neutral or alkaline, from the presence of fixed alkali or of ammonia.

(*a*) If there is fixed alkali, the blue color of litmus paper is permanent. This may occur temporarily at certain hours of the day, depending upon the meals, without any special significance; but when it is permanent, it usually points to some serious interference with the metabolism of the body. It has been noted as a precursor in affections of the nervous system, and in the early stages of cancer.

(*b*) Carbonate of ammonia is always due to a micrococcus growing in the urine; and the mucus assists it by rendering the urine less acid, or even alkaline.

## Solid Constituents.

### (*a*) *Normal.*

*Urea.*—The amount depends, to a certain extent, upon the age and the activity of the individual. According to Ralfe, the average for each pound of the body weight, if between 40 lbs. and 60 lbs., is 4½ grains; between 60 and 120, 4 grains; between 120 and 160, 3½ grains; and between 160 and 175 lbs., only 3¼ grains.

For clinical purposes the urea may be estimated with sufficient accuracy by the sodium hypobromite method, although the whole amount is not obtained by about 8 per cent.

It increases in fever, after excess of nitrogenous food, and in diabetes. Diminution may be dependent upon diminished formation, as in diseases of the liver, especially acute yellow atrophy and extensive carcinoma; or upon diminished excretion. The latter points to failing kidneys, and is a very serious element in prognosis for all operations, but especially for those involving the urinary tract.

*Uric acid* either occurs as such, forming a brick-red sandy deposit, or united with the alkalies or alkaline earths as a salt. Then it appears as a pink precipitate, rarely crystalline, which gradually settles down on the sides of the vessel as the urine cools. Neutral sodium urate is the most abundant in normal urine; the acid salt, with small quantities of the corresponding calcium one, occurs in urinary calculi and gouty deposits. Acid ammonium urate is only found after decomposition of the urea. Potassium and lithium urates are more soluble. The amount depends partly upon the supply of nitrogenous food, partly upon excessive tissue-waste and diminished oxidation. In gout, chronic diseases of the liver, and general malassimilation, it increases considerably, and is deposited wherever the circulation is feeble.

Whether it occurs in solution or as a sediment depends upon the concentration and reaction. The crystals may be recognized by their color (in the urine), by their whetstone shape, or by their being aggregated into rhombic bundles. Urates are generally amorphous, but sometimes they crystallize as rhombic needles, arranged in a stellate manner.

Oxalate of lime is met with as a deposit in neutral, acid, and faintly alkaline urine. The crystals are either octahedral (envelope crystals) or dumbbell-shaped. In many instances it is only accidental, caused by the presence of oxalate of lime in the food (in rhubarb, tomatoes, onions, etc.), or by malassimilation; and then it is usually found some hours after meals. In those, however, who are harassed, careworn, overworked, and hypochondriacal, it may be constant, and give rise to various anomalous nervous symptoms, such as frequency of micturition, pains across the loins, a sense of tightness round the chest, etc.

Oxalate of lime is closely associated with the decomposition of mucus. It is found not merely in that which is secreted by the urinary passages, but in that from the uterus, gall-bladder, vesiculæ seminales and prostate, sometimes in the form of crystals. The importance of this in the causation of calculi can hardly be overestimated.

*Phosphates.*—Acid sodium and potassium phosphate are never precipitated; phosphates of lime and magnesia are thrown down when the urine is alkaline, or sometimes if it is boiled. This may occur even when the urine is slightly acid, if the reaction is due to the presence of an acid salt.

Phosphate of lime is usually amorphous, but it may form stellar crystals similar in some respects to those of uric acid. Acetic acid, however, dissolves them at once. Magnesium phosphate is deposited with it under the same conditions. If the urine is alkaline from the presence of bicarbonates, they may be precipitated without being in excess; but under some circumstances, particularly in that state which is not seldom the precursor of diabetes and cancer, the alkaline and the

earthy phosphates are both excessive. If they are deposited in the bladder, they often cause a certain amount of irritation by collecting toward the end of micturition and coming away in a thick, creamy mass, which leaves a white crust as it dries. Fortunately, they rarely form calculi.

When the urine is alkaline from ammonia, the triple phosphate of ammonia and magnesia is thrown down in triangular prisms (coffin-lid crystals) which form masses entangled in mucus. This is the crust that develops upon calculi, foreign bodies introduced into the bladder, and even upon the surface of ulcers in the pelvis of the kidney and bladder, as soon as the urine decomposes.

### (*b*) *Abnormal.*

*Cystin* is an occasional cause of calculus. It may be recognized by its being thrown down from an alkaline solution on the addition of acetic acid. The crystals are colorless six-sided plates, and are readily soluble in ammonia. Its pathological significance is unknown; from the large quantity of sulphur that it contains Ralfe is disposed to connect it with taurin. I have met with two families in which it was present; several of the members of more than one generation were affected, but no calculi were formed; and they did not appear to be in any way inconvenienced. The sulphur may be recognized by the black precipitate obtained by boiling the cystin in liquor potassæ, and adding acetate of lead.

Xanthin is still more rare. It has been met with as gravel, especially in youths, and a few calculi are recorded. It is readily soluble in dilute hydrochloric acid, from which it may be obtained on evaporation in the form of hexagonal crystals. Like cystin, it does not give the murexide reaction, but if evaporated with nitric acid a red color is formed on the addition of liquor potassæ.

*Albumin.*—The ordinary forms are serum albumin and serum globulin; egg albumin may occur in cases of excessive consumption; hemialbumose has been noted in mollities ossium; and peptones have been found in acute septic diseases, but they are hardly of surgical importance.

Its presence may be ascertained by boiling, a few drops of acetic acid being added if the urine is alkaline; by nitric acid, carefully pouring it down the side of the tube so that the urine floats at the top, picric acid, or acetic acid and ferrocyanide of potassium. If urates are present they must be dissolved by warming, or filtered off; phosphates, which are precipitated by boiling under certain conditions, are soluble in nitric acid. The total amount passed within a certain time can be estimated by precipitation with heat, or picric acid, and allowing it to settle in a graduated tube; but the method is very rough, even when the sample tried is taken from the day's collection.

Excluding functional albuminuria (which may arise from derangements of digestion or of the nervous system, or from altered conditions of the blood), the albumin may come either from the kidneys or from some other part of the genito-urinary organs. In the former case it may be caused by inflammation (as in all the forms of nephritis); congestion, as in cardiac disease; lardaceous or fatty degeneration; or the presence of new growths. In the latter it is derived mainly from the secretion of mucous membrane. The diagnosis as to locality must be made, either from the constitutional symptoms that are present, or from other features of the urine, such as alteration in specific gravity, the presence of casts, blood, epithelial cells, etc. It must not be forgotten that the two not unfrequently coincide.

*Renal albuminuria* is of surgical importance for two chief reasons.

In the first place, the daily waste of so much nitrogenous material represents a continual loss of strength and diminished power of repair. In the second, it points to a morbid state of the kidneys, in which they are scarcely able to do their work, even under ordinary conditions. The effect, when after some operation or injury an immense extra strain is thrown upon them can be imagined: the albu-

min increases; the excretion of urea and other waste becomes more difficult; wounds heal less rapidly; and there is a much greater liability to inflammatory complications. The effect is the same in contracted granular kidney, when ordinarily there is no albuminuria, but only urine of low specific gravity and abundant quantity.

In operations on the deeper portions of the urethra, in patients suffering from albuminuria, there is a still further reason for anxiety. In all such there is a great liability to acute renal congestion, probably caused by the vaso-motor nerves. Even when the kidneys are healthy, the secretion may sustain a sudden check, and albumin and even blood appear in the urine; if they are inflamed or seriously degenerated, the secretion may stop altogether, and the operation be followed by the worst and most fatal form of urethral fever.

In all operations of expediency, therefore, the presence of albumin in the urine (and the specific gravity, if it is persistently low) must be carefully considered side by side with the physical condition of the patient, before anything is settled. Unhappily, when the urinary tract is involved, the operation is usually one of necessity rather than expediency, and the disease itself not unfrequently the cause.

Albuminuria due to amyloid degeneration of the kidneys is in some respects an exception. Even when it is constantly present, so long as the amount is small, complete recovery may follow the removal of the exciting cause.

Albumin, derived from other portions of the urinary tract, whether from the pelvis of the kidney, the bladder, urethra, or vagina, is due to the addition of mucus, blood, or pus; very rarely from the admixture of spermatic fluid. Except in the case of pyelitis, the amount is always small, and the chief importance is in the diagnosis.

*Blood.*—In the strict sense of the term, hæmaturia should not include hemorrhage from the walls of the urinary passages, following or preceding micturition; but, for the sake of convenience, they are always considered together, and the blood may come either from the kidney, bladder, or urethra.

The color depends partly upon the amount, partly upon the time that it has been mixed with the urine. If the hemorrhage is recent and profuse, as in a villous tumor of the bladder, or rupture of the kidney, the color is simply that of unaltered blood; when it is poured out slowly in the tubules, or allowed to collect in the bladder, it gradually becomes more dusky, until the tint is a characteristic smoky brown.

**Tests.**—The presence of blood in the urine may be recognized:—

(1) *By the color*, red or smoky, as the case may be. Carbolic acid gives urine a brownish hue, and certain drugs (such as senna and rhubarb) and articles of diet (beet-root, sorrel, etc.) in quantity turn it red, but they can easily be distinguished. In hæmoglobinuria the color is, of course, identical.

(2) *By the Spectroscope.*—There is a broad, dark band between D and E, which, on dilution, gradually separates into two. Sometimes there is a band between C and D, near the former (acid hæmatin), or midway between the two (methæmoglobin).

(3) *By the Microscope.*—Blood-corpuscles retain their appearance for some time in acid urine; when it is alkaline, the coloring matter soon dissolves out. In hæmoglobinuria they are absent. Hæmin crystals may be obtained in the ordinary way.

(4) *By Chemical Reaction.*—A drachm of tincture of guaiacum is placed in a test-tube; a drop of the urine added, and then some ethereal solution of peroxide of hydrogen floated upon the top. A blue ring develops at the junction if blood is present, but the same effect is produced by many other substances.

The *source* may be conjectured from the color, reaction, the presence of clots or of casts, the uniformity of the mixture, and the presence of other symptoms, such as renal colic, suprapubic pain, etc.

(*a*) *Renal Hæmaturia.*—The blood may be bright red, but usually it is

smoky, and it is always uniformly diffused. The reaction is acid, unless the quan tity is very large or there is a profuse secretion of pus; tube casts may be presen they are of themselves distinctive); a long, worm-like coagulum may come dow from the ureter, and the attack may be accompanied by severe pain in the loin renal colic, or retraction of the testicle. Blood corpuscles often cannot be detecte

(*b*) *Vesical Hæmaturia.*—The color is usually bright red, unless the urin has been retained some time in the bladder, and the mixture is rarely uniform the last drops, as a rule, contain most, whether the hemorrhage is still going o or whether it has ceased and the sediment has gravitated to the bottom. Th reaction may be acid or alkaline; irregular shapeless clots may be present (th are best seen floated out in water), but too much reliance must not be plac upon this, for the blood may have poured down from the kidney and coagulat in the bladder.

(*c*) *Urethral hemorrhage* is always bright red, the blood either preceding following the urine.

**Causes.**—Hæmaturia is due either to a morbid condition of the blood (p pura, scurvy, etc.) or to local affections, and these may be due to injury, infla mation, or new growths.

(*a*) *Renal Hæmaturia.*—Blows upon the loins and renal calculus; all for of nephritis (even granular kidney) and hyperæmia, whether active or passiv carcinoma, sarcoma, and tubercle.

(*b*) *Vesical Hæmaturia.*— Wounds (*e. g.*, rupture of the bladder) and con sions caused by calculi, catheters, etc.; cystitis in all its forms and ulceration the mucous membrane; carcinoma, villous tumors, and tubercle.

(*c*) *Urethral Hemorrhage.*—Injury, such as impacted calculus or the pass of a catheter; inflammation, as in gonorrhœa; or new growths, such as tuberc

**Treatment.**—Perfect rest and opium (unless there is nephritis, or re congestion are the most important. Cold may be applied by Leiter's coils the loins, the suprapubic region, or the penis and perineum, according to the s of hemorrhage. Vesical hæmaturia may be checked by washing out the blad with water of the temperature of 120° F., or, if the points can be seen, by tou ing them with a styptic. In urethral bleeding, a catheter may be passed, and penis gently compressed around it with a bandage; or, if it is in the region the bulb, Otis's crutch may be employed. Tincture of hamamelis is said to ch vesical hemorrhage when injected into the bladder. Infusion of matico has be used in the same way.

Gallic and sulphuric acids, acetate of lead, and ergot may be given int rarely, but if the hemorrhage comes from a vessel of any size they are of lit service.

Clots occasionally give rise to severe pain, and, if the urine is septic a [illegible] may require speedy removal for fear of decomposition a absorption. This may be done most easily by means of a soft catheter a aspirating evacuator, the clots gradually being broken up and sucked away.

Glucose is probably always present in the urine in minute quantiti [illegible] circumstances the amount increases without very special sign [illegible] may occur from excessive consumption, chronic congestion [illegible] prolonged narcosis, or the inhalation of amyl nitrite; or it may [illegible] alone, without any cause being discovered, in members of diabe [illegible] though this is always to be noted in a history, it is not of the sa [illegible] persistent diabetes.

[illegible] glycosuria is not uncommon after injuries of the head, concussi [illegible] fractures of the vertebræ, and injuries to the abdomen and kidne [illegible] more rarely, when caused in this way, it is permanent.

[illegible] affections in diabetes are due to physical causes, such as [illegible] merging into pruritus, and the eczema which is so co [illegible] vulvæ in women. Others, however, are due to the m [illegible] boils and carbuncles, for example, are of frequent occ

ence, and the latter, in particular, are of very grave import; cataract may occur in me eye or both; amblyopia, sometimes varying according to the state of health, is ot unfrequent, and, what is more serious than all, gangrene, especially of the ex- osed parts, may be caused by the least injury. It resembles, in general character, he ordinary senile form, but it is usually moist and much more rapid. For fear of his, from the susceptibility to shock, and the tendency to hemorrhage, operations, nless absolutely essential, are rarely undertaken in diabetic patients.

*Chyle and lymph* are occasionally found, coming from varicose lacteals or ymphatics, in the wall of the bladder. In the case of the former, the urine is hite, like milk; when the latter is present, it remains clear; usually it coagulates, orming a loose, soft clot, which gradually becomes liquid again. Chyluria is of special interest from its connection with the filaria sanguinis hominum.

*Fat.*—After extensive fractures, a delicate pellicle is often found floating on he surface of the urine, and the same thing has been known to occur in diabetes. Occasionally, smaller quantities, with cholesterin, etc., find their way in from the breaking down of caseous masses.

*Mucus.*—A slight amount is always present; and, especially in women, it often forms a light, transparent, floating cloud, without having any pathological significance. In catarrh it increases very greatly, and is mixed with young epi- thelial cells detached from the walls.

*Pus* may come either from an abscess bursting into one of the urinary pas- sages, or from the mucous surfaces, after prolonged irritation. If the urine is acid, it forms a thick, creamy layer; as the reaction becomes alkaline, it collects into dense, stringy masses; and if liquor potassæ is added, it forms a viscid gela- tinous deposit, like white of egg. The corpuscles, as a rule, have more than one nucleus, but, unless the quantity is excessive, it is difficult to distinguish from mucus. If both are present, the best plan, as suggested by Ralfe, is to throw down the pyin with mercuric chloride, filter it off, and then add acetic acid to the filtrate to precipitate the mucin.

Pus may come from any part of the urinary system, and in general the diag- nosis as to locality can only be made from other symptoms. If it is abundant, and the urine remains acid, it is probably derived from the pelvis of the kidney; when it is ammoniacal, and contains crystals of triple phosphate, some of it, at least, comes from the bladder.

### Urinary Deposits.

Some are derived from the urine; others from the walls of the urinary pas- sages; others again are living organisms.

#### 1. *Deposits from the Urine.*

(*a*) *From acid urine:* oxalate of lime; uric acid; urates; cystin and tyrosin.

# CHAPTER XXI.

## *INJURIES AND DISEASES OF THE BLADDER.*

### Ectopia Vesicæ.

Defective development of the anterior wall of the abdomen and front of the bladder from the umbilicus down to the penis, involving the pubic symphysis. It is more common in males than in females, and is due to the deficient growth of the mesoblast in the embryo. At birth there is a thin membrane covering in the opening, but this soon dries up and is cast off, leaving a few shreds around the margin. It is known as extroversion of the bladder, from the way in which the posterior wall with the orifices of the ureters, being entirely unsupported in front, is pushed forward like a hernia by the pressure of the viscera behind.

The appearance is characteristic at the first glance. In the pubic region, where the symphysis should be, there is a round, red, vascular projection of mucous membrane, which becomes more prominent whenever the child cries or strains. On the front of this are the ureters, with drops of urine falling from them at regular intervals. Above is the linea alba, generally very much widened, so that the two recti are far apart; below is the flattened penis, with on its surface the urethral groove and the openings of the prostatic follicles; and on each side is a rounded projection, caused by the pubic bones, which do not meet in the middle line. The testes may be present in the scrotum, or they may still be in the inguinal canal;

Fig. [illegible]—Ectopia Vesicæ in the Female.

[illegible] on the other side. The thighs are widely separated [illegible] and if the skeleton is examined the [illegible] are thin, straighter, and the pubic [illegible] than two inches.

[illegible] is so much the same that sometimes there is a [illegible] The penis, however, or the body of the [illegible] can be made out without much difficulty.

[illegible] becomes swollen and excoriated; the surface [illegible] from the constant friction and irri[illegible] growths springing up around the [illegible] This tends to dilate [illegible] the ureters, the secreting sur[illegible] inflammation,

to the very free drain that exists for the urine. Sometimes, when the ureters are dilated, the urine is ejected in small jets when any pressure is made upon the abdomen.

**Treatment.**—Many attempts have been made by reflecting flaps of skin to cover in the opening and form an anterior wall for the bladder; of these the most successful is Wood's, but even with this the greatest benefit that can be hoped for is the formation of a cavity which will retain urine for a short time with the aid of an appliance. In general, all that is possible is to cover in and protect the surface, leaving at the lower part an orifice through which the urine can drain into a urinal.

Some time beforehand the hair follicles must be destroyed by epilation and nitric acid; if left, phosphatic concretions are liable to form upon the hairs and become the source of much annoyance. The flaps are arranged so that there is a double layer in front, one with its epidermis facing the bladder, the other laid over this, raw surface to raw surface, facing the other way. The former of these, if the opening is of any size, is reflected down from the abdominal wall above the umbilicus, giving it as wide a pedicle as possible, and making it sufficiently large to reach the soft tissues on either side, and come well down on to the root of the penis. Care must be taken in doing this that the abdominal cavity is not opened, for the aponeurosis beneath is very much stretched and thinned. The flaps to cover this in are taken from either side, the root of each being formed by the side of the scrotum and the urethral groove; and they should be large enough when brought together and united in the middle line to cover in the whole of the vesical flap, and reach well on to the raw surface above it and at its sides.

In dissecting up these the greatest care must be taken not to bruise the edges or score with the knife the under surface of the skin. Hemorrhage should be checked at once by torsion. The vesical flap is laid in position first, being turned down on itself so that the epidermic surface faces the bladder. The apex is secured by two stout wire sutures, one on either side, to the margins of the urethral groove, close to the roots of the lateral ones; and the edges, if necessary, to the margins of the raw surface at the sides with catgut. Meanwhile, its surface, as well as that of the lateral flaps, is gradually becoming glazed over. When all oozing has ceased, a stream of some warm antiseptic is gently poured over to wash away any clot, and when they are thoroughly clean and dry the two side flaps are brought over the vesical one, pressed down firmly upon it by means of a sponge, and secured to each other and to the margins with wire. This covers in the whole of the bladder, leaving at its lower end an opening on the dorsum of the penis tightly embraced by the roots of the side flaps. The edges of the wounds from which the vesical flaps have been reflected should be brought together as far as possible by means of harelip-pins; the rest may be left to granulate, broad bands of strapping being fastened over the dressings to support the whole.

After the operation the patient must be kept absolutely quiet, in a sitting position, with the knees well supported and secured by bandages, so that there is no strain upon the sutures; and as this becomes very irksome, it may be necessary to keep him under the influence of some narcotic. If all goes well, the sutures may be removed at about the end of the week. Very often there is some yielding at the upper angles, especially if the flaps are rather short, and this may give rise to troublesome fistulæ. Even in the most successful cases the orifice usually enlarges, owing to the pressure on the tissues behind it, and at length requires to be covered in by some operation similar to that practiced for epispadias.

When the opening is not so large, Wood recommends that two lateral flaps only should be used, each having a pedicle springing from the scrotum and the side of the urethral groove. The size, of course, varies with the case, but they must be each of them sufficiently large to cover in the whole of the bladder. The same precautions are required as in the previous case. When the surfaces are united one is twisted round and laid with its epidermis toward the cavity, and the edges to the margins.

Thiersch's method is simpler, and succeeds better, as some of the cases acquire a certain degree of control. A new urethra is formed first. In the region of the glans a deep groove is cut on either side of the mucous membrane, and the edges are brought over and united by twisted sutures. Behind, in the penile part, a new roof is formed from reflected flaps of skin. One of these is taken from each side, and they are so arranged that while the first is reflected toward the groove (so that, when it is in position, the epidermic surface faces the mucous one), the second, which should be considerably larger, is slid over the raw surface of the other.

As soon as this is accomplished, and the parts are fairly firm, the front of the bladder is closed in. Two longitudinal flaps of skin are dissected up, one from each side, of sufficient length and breadth combined to cover the exposed mucous membrane. Each is separated at the sides and beneath, but left attached at the ends, so that the under surface may cover itself with granulations. At the end of a fortnight or three weeks, when they are thick and vascular, the upper end of the lower one is divided, so that it can be twisted on its lower attachment (which lies close by the root of the penis), and placed across the lowest part of the bladder, just above the new urethra (a groove is cut in the opposite side, by the border of the mucous membrane, to receive its upper end). Then, a short time later, the other one, which lies on a slightly higher level, is divided in the same manner and carried over the upper half. By means of these two flaps the greater portion of the cavity is covered in; the little angle above is patched up from the front of the abdomen, and the similar one below by means of a loop from the scrotum.

More recently, Trendelenburg has advocated the division of the sacro-iliac synchondrosis from behind, and the gradual approximation of the pubic bones, by properly contrived splints, until the sides of the cleft are sufficiently close to be united. The operation is performed during infancy. The left fore-finger is kept in the rectum to ascertain the position of the sciatic notch and avoid the gluteal artery. An incision from two to three inches in length is made through the soft structures on the back of the joint, from the posterior superior spine downward; the posterior ligaments are divided, and then the interosseous ones, until the joint can be forced open by lateral pressure, and the pubic bones brought together. The wounds behind are dressed and drained; and the child is placed in a V-shaped splint, well padded, to protect the bony prominences, until the healing is complete. Afterward, the edges of the cleft are deeply pared and brought together. Unless the pubic bones can be placed in apposition and sutured together, the operation cannot be considered successful; later, the cavity of the bladder must be dilated by continuous pressure with a rubber bag, and the urethra completed.

The same thing has been attempted by gradual pressure without division of the ligaments, the prominences being protected by means of rubber rings and the points varied as much as possible.

### Injuries of the Bladder.

The bladder may be injured by stabs or gunshot wounds through the abdominal wall, the rectum, or the vagina; it has been punctured through the sacro-sciatic foramen; it may be torn by one of the pubic bones in fracture of the pelvis, or wrenched from the triangular ligament by separation of the symphysis; it may be bruised to such an extent in parturition, or by the presence of the retroverted uterus, that the wall sloughs and gives way; and when it is distended it may be ruptured by compression. If the tissues are healthy, the force necessary to effect this must be considerable; if, on the other hand, they are diseased in any way, it may be altogether insignificant: even muscular action is enough.

Rupture of the bladder, therefore, is said to be either traumatic or [illegible]. In the former, the walls are sound, the force severe, and t[illegible] along the posterior surface, vertically down from the [illegible] inches. In the latter it takes the form of a ragged

sloughing edges; and the locality depends upon pre-existing conditions. There may, for example, be a pouch protruding from between the muscular fasciculi, formed only of mucous membrane and cellular tissue, and ready to give way with the least pressure; or an ulcer caused by the pressure of a catheter, or by syphilis, tubercle, or carcinoma. In other cases a calculus has been known to cause gradual thinning at one spot, until the wall broke down almost of itself; and in others, again, the tissues are so weakened from long continued distention and fatty degeneration as to yield simply from the weight of the contents.

The most frequent cause is a blow upon the lower part of the abdomen, but it may be produced by contraction of the abdominal muscles, as in lifting heavy weights; and perhaps, for the same reason, by violence applied to the back. In one or two instances, in which it has been due to a fall in a sitting position, it was probably the result of the sudden impact of the fluid against the base. The bladder must be distended, or it cannot be torn (though it may be punctured); and partly for this reason, partly because in alcoholism the protecting influence of the muscles is in abeyance, it is peculiarly likely to occur in men when they are drunk.

The rupture may be either intra-peritoneal or extra-peritoneal. Occasionally it extends through the reflection of the peritoneum; and a few instances are recorded in which the rent has been really subperitoneal, involving only part of the thickness. The character of the opening depends upon the condition of the wall: if this is healthy, it resembles a lacerated wound, and the blood pours out freely into the peritoneal cavity, or behind the pubes; when the rupture is due to ulceration, the opening is either round or irregular, with everted and perhaps sloughing edges, and the bleeding is slight.

**Symptoms.**—The typical symptoms are the feeling of something giving way; collapse, severe pain, inability to stand upright or walk, and desire, but want of power, to micturate. Not one of these, however, is always present, and the only evidence that can be relied upon is that obtained by passing a catheter; the bladder either contains only blood or a small quantity of blood-stained urine. Collapse may be wanting; patients have walked to hospital, twenty-four hours after the accident, simply from anxiety at not having passed any urine. Inability to micturate cannot be relied upon, for partial and even complete power has been retained, especially in extra-peritoneal cases. Sometimes there is no pain at all; and particularly when the accident has occurred during drunkenness, so that no history can be obtained, and it is merely a matter of conjecture whether the bladder was full at the time or not, the diagnosis may be a matter of the greatest difficulty, especially during the period when treatment is most valuable.

Even the evidence given by the use of the catheter requires consideration. If it was known that the bladder was full, and if nothing but blood or a few drops of urine mixed with blood come away, there can be very little doubt; and this little may be removed by the sensation conveyed by the instrument; it is clearly not in a cavity; it cannot be rotated or depressed; the walls everywhere are in contact with it, and cling around it. The instrument, however, may slip through the rent in the wall and enter the peritoneal cavity, or there may be only a puncture, or simple leakage, such as is produced at first by the giving way of an ulcer.

Occasionally the diagnosis is difficult for the opposite reason; the bladder has been bruised, there is a certain amount of hemorrhage, and the secretion of urine is so diminished from shock that the cavity remains almost empty for hours. It has been suggested, under these circumstances, to inject the bladder with a warm antiseptic solution, to ascertain whether it can rise well up over the pubes.

1. *Intraperitoneal Rupture.*—Immediately after the accident the bladder collapses, and the urine enters the peritoneal cavity, collecting at first at the lower part, but soon becoming diffused by the movement of the intestines. Healthy urine does not give rise to peritonitis immediately; the abdomen has been opened [illegible] hours after extravasation, without there [illegible]ever, it is left, or if the urine comes

from a bladder already inflamed, as when the wall of a sacculous slough, or a cancerous ulcer gives way, peritonitis sets in within a very few hours, and becomes general, the abdomen becoming distended, the face pinched and drawn, and the pulse rapidly failing.

2. *Extraperitoneal Rupture.*—In this the urine is poured out either into the loose tissue that lies in front of the neck of the bladder, or behind, between the bladder and the rectum, or the uterus. Sometimes there is a free exit, the perineum, or the vagina, or rectum, being torn as well. If there is not, the ordinary symptoms of extravasation of urine set in, and inflammation, followed by sloughing and septic poison, spreads rapidly into the iliac fossæ, the front wall of the abdomen, and even into the scrotum, through the inguinal canal. Generally, the peritoneum becomes involved as well before the patient dies.

**Prognosis.**—Gunshot injuries are not so fatal as might have been expected; the urine escapes through the wound, and retention and decomposition are prevented. The same occurs when the bladder is wounded by foreign bodies pushed into it through the rectum or vagina, or when it sloughs in consequence of pressure during parturition. When there is no external wound, or easy exit for the urine, it accumulates, decomposes, and acts as a virulent poison.

**Treatment.**—The first indication is to remove the urine that has already escaped, the second is to close the rent in the bladder so as to prevent further extravasation.

Until within the last few years there was no certain case of recovery after rupture of the bladder into the peritoneum. Various methods had been attempted: the abdomen had been opened, thoroughly cleansed, and the wound in the bladder closed; but either leakage had taken place or the sutures had given way. The peritoneal cavity had been washed out through the rent. The bladder had been drained, not only by catheters, but by median and lateral cystotomy, to prevent the exit of any more, hoping that the peritoneum would be able to deal with that already present; but all without avail. It was not until Lembert's fashion of suturing the intestines was applied to the bladder that there was any success, and then MacCormac's, Holmes's, and Walsham's cases followed rapidly one after the other. Now there is no doubt: the patient is placed under an anæsthetic; a rubber bag introduced into the rectum to raise and fix the floor of the bladder; and an incision made in the middle line, ending just below the upper border of the pubic symphysis. The extra-peritoneal portion of the bladder is examined first by gently pushing the folds of peritoneum upward. If there is no extravasation of blood there, or evidence of bruising, the peritoneal cavity itself is laid open and the rest of the bladder carefully felt. If there is a rupture, the edges are steadied and drawn forward by hooking up the nearer end with a blunt and rounded retractor (a suture is unnecessary and only inflicts further injury), and then a series of Lembert's sutures passed close together, commencing in the sound tissue beyond either end of the rent and carefully avoiding including any of the mucous membrane. Greig Smith recommends a double row, one to transfix the cut muscular surface, the other, Lembert's, outside this; and that all should be passed before being tied. The intestines are held back out of the way, in the meantime, with a soft, flat sponge. Then the abdominal cavity is cleared of all blood-clot and urine that may have found its way in, and irrigated either with warm water (temp. 100° F.), or with a dilute solution of some non-poisonous antiseptic. The wound should be closed in the usual way, introducing a drainage-tube only when there is already peritonitis. If there is any doubt as to the security of the sutures in the walls of the bladder, they can be tested first by distending the cavity through a catheter. Silk is the best material, and the sutures should not be more than one-eighth of an inch apart; catgut, even if it were so certain, is difficult to knot securely when the wound lies deep in the cavity of the pelvis. In one or two cases the difficulty has been so great that it was necessary to make a short transverse incision through the peritoneum on either side.

After the operation the bag in the rectum is emptied and

pository or a hypodermic injection of morphia given, and the patient kept warm and quiet in bed, with only a small quantity of ice to suck or a few teaspoonfuls of milk. At first there is very little urine secreted, and if the sutures are sufficiently close there is no need to pass a catheter, much less to tie one in, or perform cystotomy; the bladder is able to empty itself without risk.

Extra-peritoneal rupture must be treated on the same principles. If the rent can be secured from the front, an opening should be made over the pubes, and Lembert's sutures passed as before; only, as it is impossible to remove the urine from the loose cellular tissue around the bladder, the abdominal opening should not be closed and a large drainage tube should be inserted. Wounds involving the rectum or vagina, if not very large, may be left for a time; very frequently they close in: or, if not, contract so that the resulting fistula is much smaller. Wounds in other parts are usually complicated by other injuries.

## DISEASES OF THE BLADDER.

### ATONY.

The bladder is said to be in a state of atony when the muscular power is impaired, without there being any evidence that the nervous system is affected.

Atony may occur when the walls are healthy, but it is much more likely if the strength of the muscles is enfeebled by old age or inflammation. In such cases, even passing a catheter or drawing off residual urine may abolish the small amount of power that still remains.

Atony may be caused by a single act of retention; the bladder becomes overdistended; the muscular fibres over-stretched; and all power is lost, perhaps for life. This may happen even in voluntary cases, although it is more likely if the obstruction is mechanical. More frequently the loss of power is gradual and slowly grows worse; the bladder is imperfectly emptied; some urine always remains behind; the amount grows larger and larger; the muscular coat becomes accustomed to it; and at length the bladder remains full, the urine falling out of it, drop by drop, as it enters from the ureters (overflow).

Obstruction sometimes causes atony, sometimes hypertrophy. The difference depends, to some extent, upon the age and strength of the patient; the effect of retention is different naturally in an old man of feeble health and in a younger one of vigorous life; but the chief causes are the rapidity with which the obstruction is produced and the amount of irritation at the neck of the bladder. In cystitis, for example, and in cases of enlarged prostate in which there is much spasm, hypertrophy usually results. When, on the other hand, the prostate is tender and painful as the bladder contracts and presses upon it, the patient, perhaps unconsciously, tries to save himself and quietly stops before he has finished. If this happens constantly, the bladder at length loses the power of emptying itself, and atony sets in. The same thing happens from purely mechanical causes in enlargement of the prostate: the bladder becomes accustomed to retain a certain amount of urine, and after a time is unable to expel it.

The immediate result of atony is distention and dilatation, owing to the pressure of the urine: the bladder grows thinner; the muscular fibres degenerate, and at length the ureters and the pelvis of the kidneys become affected. Cystitis and pyelonephritis nearly always follow, sooner or later: there is everything to favor their occurrence; and if the urea decomposes the walls of the bladder may slough.

**Symptoms.**—Increased frequency of micturition is the most prominent: if the bladder is over-full, the urine flows away without cessation; if there is less, it escapes on coughing or laughing, or at night, giving rise to extreme annoyance; and the patient either complains that he is passing too much water, or that he cannot retain it. In some cases the bladder is distended nearly up to the umbilicus,

cases a catheter must be passed at once; if the patient can wait, relief can sometimes be obtained by free leeching in the perineum and by hot baths, the temperature as high as can be borne, for at least half an hour. A full dose of opium should be given at the same time, and the bowels opened freely. Even if this is not successful it makes it easier to pass a catheter afterward, procures sleep and quiet, and tends to prevent the occurrence of rigors and other secondary troubles. Afterwards the patient must be kept in bed, on milk diet without any stimulants, and the urine rendered as unirritating as possible. In cases of gonorrhœa, or when there is a prostatic abscess, this may have to be repeated night and morning for several successive days.

(*b*) *Stricture.*—In this case the distention may be so gradual that the bladder rises as high as the umbilicus before the patient is in the least concerned about it. The urine flows away drop by drop, and this generally is the cause of complaint; there is little or no pain, and no fever, although the health is sure to fail, from the interference with the action of the kidneys. A moderate-sized catheter should be tried first, then smaller and smaller ones, but always with the utmost gentleness. The more soft and flexible the instrument, especially near the point, the more likely it is to be guided by the folds of the mucous membrane into the orifice of the stricture. Black ones, slightly bulbous at the tip, with a flexible neck, are the best; small metal ones are excessively dangerous. If these fail, a catgut bougie will sometimes succeed, and, if it passes, the urine will find its way readily by the side; but, in the majority of instances, when the constriction is so tight, it is not advisable to persist. Retention is seldom due solely to organic stricture; the urethra is narrowed by this at one point, and rendered so sensitive that the slightest irritant will close it completely by the spasm and congestion it excites. Prolonged irritation with a catheter only makes this worse. Cocaine is of very great service; a few drops of the ten per cent. solution, injected on to the face of the stricture, will frequently turn the scale; but it is better, if the catheter does not pass after a very moderate trial, to place the patient at once in a hot bath and give him a full dose of opium. This nearly always succeeds; and, generally, if he is kept in bed, on light food, without stimulants, if the bowels are kept freely open, and hot baths given night and morning, in a few days the spasm and congestion are relieved to such an extent that a catheter can be passed with ease. The only alternative is to give an anæsthetic, try again, and, in case of failure, puncture the bladder. The result, so far as the stricture is concerned, is the same, but at the expense of an operation. [Median perineal cystotomy is always preferable to puncture.]

(*c*) *Enlarged Prostate.*—This may cause retention, either by the third lobe falling over the orifice, like a valve; or by sudden congestion, narrowing the elongated and tortuous passage to such a degree that the already enfeebled muscular coat is unable to overcome the resistance. The symptoms are usually very acute, the pain is exceedingly severe, and delirium and extreme prostration set in almost at once. For this, opium and hot baths can do no good, and often they are positively dangerous. A catheter must be passed at once, either a silver one with a long, sweeping curve; a gum elastic, provided with a stilet, so that the end can be tilted up; or a black one with the point bent at an angle (*coudé*), so that it can ride over the obstruction. Unless a stricture is present as well, the largest catheter that will pass the meatus should always be selected, and, owing to the growth of the prostate, it should be of extra length. Violence is never justifiable, but it is often necessary, when passing a catheter under these conditions, to make use of steady but firm pressure. The urine is nearly always bloody afterward, perhaps for several days, owing to rupture of the vessels of the mucous membrane and the blood finding its way back

If this does not succeed, the choice lies between
through the substance of the prostate or tappi

## Tapping the Bladder.

This may be required, either as a temporary measure, to give relief until the natural passage can be reopened, or as a permanent means of exit in impermeable stricture or enlargement of the prostate. It may be performed either over the pubic symphysis, through the perineum (going either through or behind the prostate), or through the rectum. In exceptional instances, where, as in cases of extravasation of urine or advanced cystitis, the object is rather to drain the bladder than to relieve retention, the prostatic portion of the urethra may be opened in the middle line, at the apex of the gland (*la boutonnière*); and sometimes this is done in case of stricture (Cock's operation).

### *Suprapubic Tapping.*

This may be performed either with an aspirator or with an ordinary but rather curved trocar and cannula. When the bladder is distended there is abundant room; but especially in old cases of cystitis, the posterior surface of the symphysis must always be followed. If the relief required is only temporary, the aspirator may be used, a small incision being made in the skin with a scalpel, and the trocar pushed through it into the bladder, downward and backward. No extravasation follows, as the mucous membrane glides upon the muscular coat when the bladder collapses, and the orifice becomes valvular. If necessary this may be repeated two or three times without much danger, and I have known it done night and morning, for more than a week, without any ill result; but, if it is continued, there is always a risk, either of leakage taking place through the wall of the bladder, or without there being any direct opening, of an abscess forming in the loose cellular tissue, between the layers of the transversalis fascia, possibly due to the escape of irritating material from the end of the cannula as it is withdrawn.

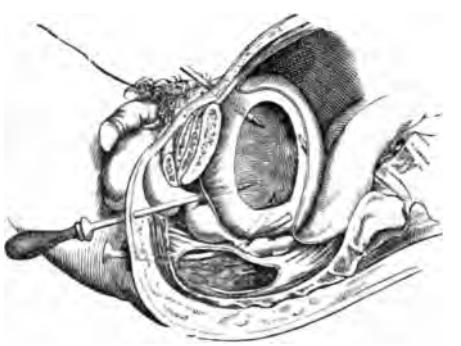


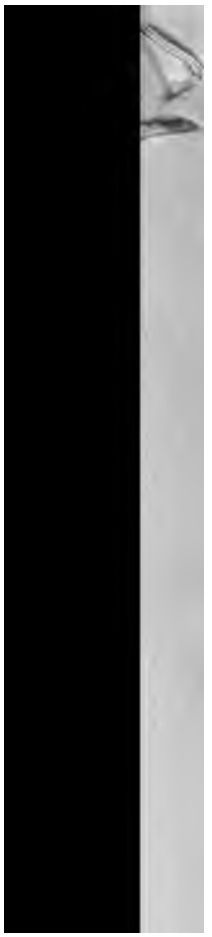
Fig. 431.—Tapping the Bladder. (1) Suprapubic; (2) Perineal: (3) Rectal.

When a permanent opening is required a large trocar (with a linear, not a triangular, cutting edge) and cannula may be introduced in the same way. On withdrawing the trocar, a soft india-rubber tube is passed down the cannula and left when this is removed. The other end of the tube may be carried under the bed-clothes to a receptacle. After a few days the tissues become consolidated and form a short, straight canal, which can be fitted with a rubber tube and stop-cock. Owing to the contraction of the sinus there is no leakage, and I have known patients to go about with this arrangement, in perfect comfort, for years.

In exceptional cases, after suprapubic cystotomy for enlargement of the prostate or tumor of the bladder, the opening has been allowed to contract to a sinus and the same arrangement made use of.

### 2. *Perineal Tapping.*

Post-prostatic tapping through the perineum has recently been advocated by Howlett. The patient is placed in the lithotomy position, the forefinger of the left hand passed into the rectum as a guide, and an incision made in the perineum behind the bulb; a trocar and cannula is then pushed onward between the prostate and the rectum, until the bladder is entered. This is known by the cessation of the resistance. A tube is introduced afterward, and worn so long as the patient



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**Causes.**—1. Injury, mechanical or chemical. The former includes wou and contusions from calculi or instruments; tension, as in stricture and enlar prostate; and bruising or straining, as in parturition or displacement of the ute the latter, irritating conditions of the urine, due to uric acid, cantharides, and, m than anything else, carbonate of ammonia and other products of decompositi

2. Infective organisms, such as tubercle, and new growths, such as carcino Even non-malignant tumors of the bladder are always attended with a sli degree of cystitis.

3. Extension from surrounding parts, especially in the case of gonorrhœa stricture. It may occur in peritonitis, and, exceptionally, in diseases of o neighboring structures.

**Pathological Appearances.**—In the milder forms of acute cystitis, s as occur in gonorrhœa, the mucous membrane is thickened and swollen, the thelium detached, leaving the surface raw and bleeding, or covered over with fla of lymph and reddened in patches, owing to small extravasations. When i more severe it may be lined with a slough, which can be peeled off like a di theritic membrane; the color is dark crimson, or, if it is some time after dea even black; the mucous membrane is sloughing and gangrenous; the submuc tissue and even the muscular coat infiltrated with pus; and sometimes peritoneal surface involved as well, either covered with lymph from recent p tonitis, or, in the worst cases, perforated from ulceration.

In chronic cystitis the bladder is either thin-walled and distended, or sm hard, and inelastic, so that it can neither expand nor collapse. In the former c the mucous membrane is thinned and stretched and generally slate-colored or d from old hemorrhages, the submucous coat can hardly be found, and the musc fibres are wasted until scarcely a trace of them is left. In the latter the interio rough and uneven; here and there it is bright red from extravasated blood other parts almost black, especially along the veins. The mucous membran thickened and velvety, or studded with superficial excoriations and even ulce and it is smeared all over with a grayish, intensely offensive, tenacious mas mucus and phosphates. The submucous tissue in some parts is hard and de from long-continued inflammation, in others riddled with abscesses. The mus lar coat is thickened into great bands which extend around the bladder, divid and joining again, so as to leave between them lozenge-shaped depressions. In cases these grow out into thin-walled sacculi or pouches with very narrow nec and once formed, they are permanent (Fig. 433); each time the bladder contracts more fluid is driven into them; there is no muscular coat, so they cannot empty themselves; and at length they become half-filled with mucus. Other pouches are sometimes due to the gradual yielding of the whole thickness of the wall; but these seldom occur unless there is a calculus (Fig. 437) or a great development of the inter-uretral bar. In some of these the wall is forced down behind the prostate until it is possible to tap the bladder directly through the perineum.

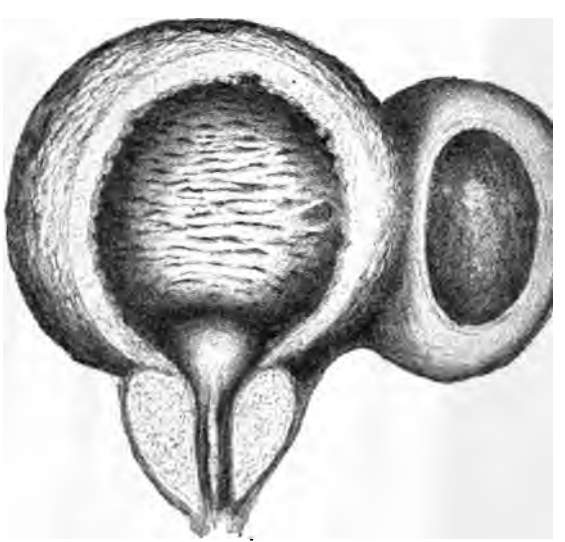


FIG. 433.—Hypertrophied and Fasciculated Bladder Consequent on Enla ment of the Median Lobe of the Prostate. A large, thin-walled sacc with a very small orifice has been forced out on the left side.

When ammoniacal decomposition of the urine

occurs in a bladder already the seat of chronic cystitis the changes are more extensive still. The walls are constantly bathed with an intense irritant; the sacculi are filled with a most offensive mixture; ulceration and sloughing follow; the pus spreads into the submucous coat and between the muscular fibres, even to the peritoneum; and at length the bladder is reduced to the condition of a sloughing abscess, filled with putrid fluid, under constantly increasing tension.

When ulceration occurs at an early period it is usually due to injury (such as the pressure of the point of a catheter tied in) or to tubercle. In the latter case the trigone is chiefly affected, and the ulcers are multiple, slightly raised at the margin, circular in shape, and covered over with a yellow granular slough. Tubercle bacilli may be found on the surface and sometimes in the urine.

In cystitis the inflammation never remains limited to the bladder for long; very soon it spreads to the ureters and involves the pelvis (pyelitis); thence it extends into the substance of the kidney itself. So long as the nephritis is not very intense, there is merely an increase in the amount of connective tissue, with some diminution of the secreting power; if, however, the urine decomposes, and the products gain the pelvis, suppuration and multiple abscesses occur very soon.

**Symptoms.**—*Pain.*—When the inflammation is very acute, or when there is ulceration, this is described as agonizing, radiating to the groins, down the thighs, and all over the lower part of the body, with unceasing desire to pass water (*strangury*), and such an amount of spasm that only a few drops of blood-stained fluid are ejected at a time. In the gonorrhœal form it is less severe; and as the inflammation becomes chronic it may almost disappear. Generally, however, there is a dull aching over the pubes and in the perineum when the bladder is distended and as it begins to contract, when, that is to say, tension falls upon the inflamed mucous membrane; and for the same reason there is tenderness on pressure over the same regions, and on examination per rectum or with a catheter.

Contrary to what occurs in calculus, the pain is less severe after the bladder is emptied.

*Increased frequency of micturition* is never absent, unless there is some insurmountable obstacle. If the cystitis is severe the urine is ejected every few minutes with violent spasm; in milder cases the intervals are longer, but the call scarcely less urgent.

The *character* and frequently *the amount of urine* are altered. In very acute cases the quantity is greatly diminished, and it consists of little more than blood, mixed with shreds and flakes of lymph from the surface of the mucous membrane. In gonorrhœal cystitis it is cloudy and turbid with mucus; blood is usually present, especially toward the end of the micturition, when the muscles at the neck of the bladder are contracting upon the congested mucous membrane; but the amount of urine generally remains the same. As the inflammation grows chronic the hæmaturia diminishes and may even disappear; but blood corpuscles can generally be found in the sediment.

In chronic cystitis, so long as the urine is acid, the deposit consists only of mucus mixed with minute organisms, detached epithelium, a few blood-corpuscles, urates, and oxalate of lime. When decomposition sets in the smell becomes ammoniacal and intensely offensive, and the deposit is largely increased; a thick, viscid, gelatinous mass gradually sinks down to the bottom whenever the urine is allowed to collect, and clings tenaciously to the sides.

*The constitutional disturbance* in chronic cystitis is rarely severe, though the health always suffers from the irritation and want of rest and from the changes that are induced in the kidneys. Traumatic inflammation, if the bladder was healthy before the injury, may be attended with a certain amount of fever, sometimes with shivering; but, unless the cause is persistent, it soon subsides. In gonorrhœal cystitis the temperature occasionally ranges very high, and there is for a time great anxiety, with distress. The worst cases are those in which, owing to injury or decomposition of the urine, an acute attack suddenly breaks out in a bladder which, from atony, enlarged prostate, or any other cause, cannot completely

empty itself. The urine rapidly becomes putrid; the tension grows higher and higher; the poison is absorbed through the inflamed and ulcerated walls; and owing to the kidneys being nearly always involved as well, there is very grave danger of suppression of urine. The temperature does not rise very high; but the patient becomes delirious; the most extreme exhaustion sets in; the symptoms assume a typhoid character, and death may ensue in the course of a few days.

**Prognosis.**—This depends upon the cause and the condition of the bladder, though naturally the secreting power of the kidneys is especially important. Inflammation, excited in a healthy bladder by a transient agent that can be removed at once, soon gets well. On the other hand, if the irritant is persistent, as in the case of tubercle or carcinoma, or if the bladder is rough and irregular, with rigid walls that cannot collapse, or studded with pouches that cannot be emptied, or if there is any obstacle to complete evacuation, the attack may be stopped for a time, but it is always ready to break out again.

**Treatment.**—1. *Acute Cystitis.*—The first thing is to remove the cause; the second, to give the bladder rest. If it was previously healthy and the irritant was a transient one (lithotrity, for example), active local measures are not required. The patient should be confined to bed, on milk diet, the bowels thoroughly opened, and a hot bath given night and morning. If there is much pain or throbbing, leeches may be applied to the perineum; and if the bladder is very irritable, morphia and belladonna may be given, either in the form of a suppository or as a pessary introduced into the bladder at night. Alkalies are not of much service, but if the urine contains an excess of uric acid, ten-grain doses of citrate of potash may be given with hyoscyamus. Iced barley-water and similar drinks may be taken freely if the patient is hot and feverish; but buchu and triticum repens are of little use at this stage. If retention occurs from congestion of the mucous membrane at the neck, a soft or black catheter should be passed.

2. *Chronic Cystitis.*—In this again the cause must be ascertained, and, if possible, removed. Irritating conditions of the urine, for example, such as occur in gout and ill-fed strumous children, must be treated by attention to the digestive organs. Stricture must be dilated or divided; calculi removed; vascular growths about the urethra excised; and displacement of the uterus rectified.

(*a*) *Constitutional.*—In some cases—tubercular cystitis, for example—this is almost all that can be done; in all it is very important. The clothing must be warm; exposure to cold and over-exertion avoided; diet regulated; stimulants, coffee, etc., prohibited; and the bowels kept gently relaxed. If there is much mucus (mucus does not cause fermentation of urea, but it assists it, partly by lessening the acidity, partly by coating the urethra with a stagnant layer of alkaline fluid, in which the ferment grows with ease), quinine, boracic or salicylic acid may be given internally. Benzoate of ammonia helps to keep the urine acid; triticum repens, pareira, and buchu check the catarrh, but the two last often disagree; and copaiba, sandal oil, and other resins are of service in the same way, especially in chronic cystitis with abundant secretion. In most cases, however, when the stage is reached, local measures are required as well.

(*b*) *Local.*—Washing the bladder is exceedingly useful in checking the formation of mucus, clearing out the adherent coating, and preventing decomposition; but it must be distinctly recognized that, unless it is done with the greatest care, it may easily do more harm than good. The utmost gentleness must be used, and, unless there is some special condition, the amount injected should never exceed four ounces. The simplest contrivance, one which the patient can easily manage for himself, is a glass funnel attached by flexible tubing to a large-eyed soft catheter. As the funnel is raised, the fluid pours into the bladder by its own weight; as it is lowered, it falls back again; and if it is turbid, it can at once be replaced by fresh. When there is a large amount of phosphatic debris, or of thick, tenacious mucus, a modification of Higginson's syringe with a double-way tap or a lithotrity evacuator may be employed; but the amount of force must be accurately gauged with the hand. Bladders with softened walls are easily ruptured.

The most useful solutions are corrosive sublimate (1 in 10,000, with a drop of hydrochloric acid); iodoform, gr. x ad ʒj, suspended in mucilage, especially for tubercular cystitis; quinine, with a drop of sulphuric acid; boracic acid, gr. x ad ʒj, with glycerine, nitrate of silver, and acetate of lead. But hot salt and water, dilute nitric acid (especially if there is much phosphatic debris), permanganate of potash, sulphate of zinc or copper, and many others may be employed. It seems of some advantage, when there is much mucus, not to continue with the same one too long. Carbolic acid, unless very weak, is too irritating.

Even when the urea has decomposed and the urine is ammoniacal, so that a fresh and very grave source of irritation is added, washing out the bladder, if it is done carefully, and if the condition of the walls and of the kidneys is not too far advanced, is very successful. The germ upon which the fermentation depends is killed; the decomposition stopped; the excess of mucus washed away; and the inflammation of the mucous membrane gradually subdued.

*Exploration and Drainage.*—If this fails, the interior of the bladder may be explored either with the cystoscope or with the finger. In some instances a piece of soft rubber tubing has been found, of course, without any history; in others a pouch spreading out from the bladder; or a new growth; or sometimes, especially in young subjects, a deposit of tubercle breaking down. The cystoscope may be used at an early period. Digital exploration of the male bladder necessitates an opening in the perineum; but the operation is an exceeding simple one, almost unattended with danger, and in nearly all the cases in which it is required for diagnosis it is equally valuable for drainage. A grooved staff is passed down the urethra into the bladder; the patient is placed in the lithotomy position; a small incision made exactly in the middle line, three-quarters of an inch in front of the anus, and deepened until the finger-nail can feel the groove. Then the membranous portion of the urethra is opened above the bulb, and a probe or gorget pushed along the groove into the bladder. The staff is now withdrawn and the forefinger gently pressed through the prostatic portion, dilating it as it goes.

The further treatment depends upon what is found. If there is tubercular cystitis, and the disease is not too far advanced, iodoform or dilute lactic acid may be applied; or suprapubic cystotomy performed and the ulcers scraped, though the cases in which such a proceeding is advisable are very few in number. If there is a foreign body or a tumor, it may be removed; a sacculus may be drained; and other conditions dealt with according to circumstances.

When the cause is irremediable, as in advanced tubercle or carcinoma, simple drainage through a perineal opening gives more relief than anything else: the patient is freed from pain; he is able to obtain a certain amount of rest at night, and, for a time at least, he may gain a certain amount of strength. Even when no cause for the cystitis is found, and sometimes it will persist in a most inexplicable manner, draining the bladder through the perineum—giving it perfect rest for a month, and allowing all the urine to flow out through a tube—has in many instances effected a permanent cure.

This operation is imperatively required when chronic cystitis that has lasted perhaps for years, and has produced serious changes in the kidneys and in the wall of the bladder, suddenly becomes acute. This may be due to lithotrity, especially if the fragments are not thoroughly cleared away; or to the use of instruments, or to decomposition of the urine in cases of atony and enlarged prostate. The symptoms are of the gravest description: the kidneys are already in a state of interstitial, sometimes of suppurative, inflammation; there is partial suppression of urine; the bladder is unable to expel its contents; the walls are intensely inflamed, perhaps sloughing; septic absorption is rapidly taking place, and the patient is in imminent danger of sinking into a state resembling typhoid. Under such conditions there is no alternative: the bladder must be opened at once and allowed to drain just like any other offensive abscess. In many cases the patient sinks from exhaustion; but sometimes the mucous membrane clears itself with surprising rapidity; the urine loses its offensive character; the amount and the specific gravity both increase; and the strength and health are gradually regained.

but sometimes they are flattened, and occasionally they are covered with facets from mutual friction. In rare cases where the bladder is sacculated and the calculus lies partly inside the pouch, it is moulded into the shape of an hour-glass. The surface varies according to the composition, those formed of oxalate of lime being peculiarly rough and characteristic.

It rarely happens that a calculus is homogeneous throughout. With the exception of some formed of cystin, which have a peculiar radiated appearance, the surface of the cut section is made up of concentric layers, varying in character and structure according to the reaction and composition of the urine. Laminæ of oxalate of lime, more or less pure, alternate with those of uric acid; or a soft earthy layer of urate of ammonia may be interposed between others of mixed composition. Owing to the roughness of their surface and the amount of irritation they cause, nuclei of oxalate of lime are generally coated over with phosphates. Calculi sometimes suddenly undergo spontaneous disintegration, and break up. Probably the immediate cause is an alteration in the reaction or the specific gravity of the urine, so that the solubility of the different layers is no longer the same; and sometimes, after this has happened, the irritation arising from the presence of numerous angular fragments brings on an attack of cystitis, and the isolated portions become welded together again with triple phosphate.

**Position.**—For the most part calculi lie at the back of the bladder behind the prostate; sometimes they are caught behind the pubes in front; and occasionally they lie in cysts, either large sacculi with very small openings, which are formed as hernial protrusions of the mucous membrane between the fasciculi of the muscular wall in hypertrophied bladders (Fig. 433), or little cavities which the calculi work out for themselves. These are most common on the right side at the base, close to the orifice of the ureter, and they fit so accurately round the stone that it may require considerable force to dislodge it (Fig. 437). All the layers of the bladder wall, very much thinned and stretched, enter into their structure, and when the calculus lies behind the prostate the orifice of the sac may be almost closed during life by the muscular bands contracting and pressing the stone deep into the substance of the gland. Phosphatic concretions are occasionally found upon growths projecting into the bladder; and it is said that calculi are sometimes adherent to the mucous surface.

FIG. 434.—Uric Acid Calculus, with Nucleus of Oxalate of Lime.

*Chemical Reactions of Calculi.*—The calculus should be finely pounded and divided into four parts.

1. One portion is placed on platinum foil, and heated before a blow-pipe.

(*a*) It disappears, or nearly so: uric acid or urate of ammonia.

(*b*) It clears to some extent: probably oxalate of lime; if so, the residue effervesces, and dissolves with hydrochloric acid.

(*c*) It fuses readily into a porcelain-like mass: triple phosphate, mixed with phosphate of lime.

2. The second is moistened with hydrochloric acid.

(*a*) It dissolves: oxalate of lime, phosphate of lime, or ammonio-magnesian phosphate. Carbonate of lime, and oxalate that has been heated, effervesce as well. Xanthin also dissolves.

(*b*) It remains unaltered: uric acid; urates; or cystin.

3. The third is warmed with liquor potassæ.

(*a*) It dissolves: uric acid; urates; cystin; or xanthin. The two former give the murexide reaction; the latter do not. If ammonia is present, it is given off when the solution in liquor potassæ is heated.

## GENERAL CHARACTERS OF CALCULI.

| — | Shape and Size. | Surface. | Fracture. | Color. | — |
|---|---|---|---|---|---|
| 1. Uric acid, . . . . | Ovoid or round, varying in size from gravel to that of a hen's egg, or even larger. | Smooth, or slightly granular. Susceptible of a fairly high polish. | Crystalline in proportion to purity. Brittle, but hard. | Yellow to red or reddish brown. | Uric acid calculi are the most common of all, and are always deposited in acid urine. Usually they occur at the extremes of life. |
| 2. Urates, . . . . . | Ovoid, rarely so large as the former; often multiple. | Smooth and earthy. | Earthy and inclined to crumble. If it forms the whole, homogeneous, but in general much laminated. | Fawn or whitish gray. | Most common in children, mixed with lime oxalate. Usually acid urate of soda, but with some of lime and ammonia. |
| 3. Oxalates, . . . . | Irregular, sometimes in the form of hempseed calculi. | Tuberculated . . . | Crystalline and very hard. | Dark brown and even black, from repeated hemorrhages. | Usually layers of oxalate alternate with others of uric or urates. Very often coated with phosphates. |
| 4. Mixed phosphates, | Depends on that of nucleus. | Smooth and friable. | Chalky, soft, and breaking easily. Occasionally small crystals on the surface. | White or gray. | Only deposited after decomposition of the urea. |
| 5. Phosphate of lime, or bone earth, | Rarely of any size . . | Smooth and soft . . | Breaking easily with crumbling fracture. | White. | |
| 6. Cystin, . . . . . | Ovoid and generally of medium size. | Finely granular, with small yellow crystals over it. | Soft and crystalline. | Yellow, turning pale green after exposure, with a somewhat radiated appearance. Waxy. | Usually pure, but sometimes on a uric acid nucleus. |

(*b*) It remains unaltered: oxalate, phosphate, or carbonate of lime.

4. The fourth is moistened with acetic acid; if it dissolves, it is either carbonate or phosphate of lime.

Besides these, concretions have been found in the urinary bladder, formed of fatty matter, with a certain amount of urates or phosphates (urostealith); of fibrin, blood, and even of indigo, derived from the indican; but they are all extraordinarily rare.

**Symptoms.**—The cardinal symptoms of stone are pain, increased frequency of micturition, hæmaturia, and sudden stoppage in the stream of urine. They are worse with small calculi than with large ones, because the latter remain stationary in the bladder, and do not roll about and irritate the mucous membrane; they are more marked when the bladder is empty, because, so long as it is full, the calculus lies in a fluid of higher specific gravity than water, and, though it does not actually float, it cannot come into forcible contact with the walls; they are worse with oxalate of lime calculi, because their surface is so rough; and most severe of all when the mucous membrane is inflamed.

FIG. 435.—Calculus composed of Oxalate of Lime: Surface and Section.

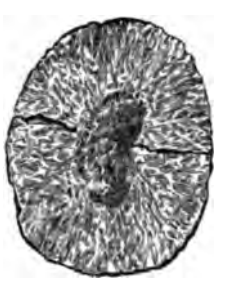


FIG. 436.—Calculus composed of Cystin.

FIG. 437.—Hypertrophied and Fasciculated Bladder, with Enlargement of Prostate. A calculus was buried in a deep pouch behind the gland, and the orifice was so firmly contracted around it that at the post-mortem there was some difficulty in dislodging it.

1. *Pain.*—This is of two kinds. The one is a constant, dull, aching sensation across the loins, in the groin, and running down the thighs; worse on movement, especially riding, driving, or jumping. The other, which is more characteristic, is an intense cutting or shooting pain, felt at the end of the penis as the fluid leaves the bladder, and the sensitive mucous membrane at the neck is crushed down upon the rough and hard surface of the calculus. Children, toward the end of micturition, scream with pain, and pull upon the penis, until the prepuce is immensely elongated. Violent straining often occurs at the same time, the contents of the rectum are discharged involuntarily, and the mucous membrane, especially if any piles are present, often becomes prolapsed.

2. *Increased Frequency of Micturition.*—This is especially marked during the daytime, while the patient is moving about; at night, contrary to what occurs when there is enlargement of the prostate, the bladder is at rest, because the stone is quiet. When cystitis sets in, this symptom is very troublesome.

3. *Hæmaturia.*—Blood is frequently present in the urine after exertion; but

it is only characteristic if the urine itself is clear, and at the end of micturition, when the pain is coming on, a few bright red drops follow.

4. *Sudden Stoppage of the Stream of Urine.*—This is not so common; it may occur, however, from the stone falling against the neck, especially in children, and setting up spasmodic contraction of the sphincter.

*Latent Calculus.*—The symptoms of calculus are occasionally masked to such an extent that its presence is never even suspected.

This may occur with very large, smooth, and rounded calculi. They remain perfectly quiet; there is no hæmaturia, pain, or spasm; merely increased frequency of micturition, owing to the diminished capacity of the bladder. Stones of over a pound in weight have been found *post-mortem*, without the inconvenience ever having been sufficiently great to make the patient apply for treatment.

It may also happen if the prostate is much enlarged, without there being any cystitis. The calculus remains behind the projection, and never comes into contact with the neck; the symptoms never become urgent. Chronic inflammation of the bladder is always present in encysted calculus.

*Consequences of Calculus.*—Inflammation always breaks out sooner or later; at first the mucous membrane only is involved, but very soon it spreads to the submucous and muscular coats; the cavity shrinks, the walls become rigid, inelastic, and irregularly thickened; sometimes sacculi develop or ulceration sets in, and the mucous membrane becomes coated with an intensely offensive layer of putrid pus and triple phosphates. Dilatation of the ureter and of the pelvis of the kidney always follows; the cortex is absorbed; the connective tissue increases in quantity; the secreting power is diminished; the urine becomes ammoniacal, and the inflammation rapidly spreads upward, involving the pelvis and the substance of the kidney, and causing suppurative pyelonephritis.

FIG. 438.—Thompson's Metallic Sounder.

**Diagnosis.**—The presence of a calculus can only be proved by exploring the bladder with a sound or a cystoscope.

Sounds are made of steel, for the sake of the polish. The handle may be cylindrical or flattened and rougher on one surface than the other, so that there may be no mistake as to the direction of the beak. The shaft is round, nine inches in length, and about the size of a No. 7 English catheter; the beak is an inch and a quarter in length, slightly bulbous at the end, and is bent up to an angle of 120°. For children, of course, they are smaller. Sometimes it is of advantage to have them hollow, so that the amount of fluid in the bladder can be varied. With children it is always advisable to give an anæsthetic; in an adult an injection of cocaine does a great deal toward diminishing the discomfort.

The same precautions should be taken in passing a sound as in passing a catheter. Fatal consequences have occurred even in children with perfectly healthy kidneys. The patient should, if possible, be prepared beforehand, and should remain quiet afterward. It is best if he will keep his room, and, if there is the least suspicion with regard to the kidneys, even his bed, for the rest of the day. A large cupful of hot tea with five grains of quinine and a few minims of laudanum is an excellent precaution. If there is any retention afterward it may be relieved by a full dose of opium (provided the kidneys are not affected) and a hot bath.

For choice, the bladder should contain four or five ounces of urine; if there is more than this, a small calculus may easily elude the sound; if less, the folds of the mucous membrane may collapse around it and cover it in. In children and young adults, in whom there is no reason to suspect chronic retention, it is sufficient if the bladder contains the secretion of the last hour or two; but in older

men, with possible atony and enlarged prostate, or where there is any difficulty, it is better to pass a soft catheter first, empty the bladder thoroughly, and then inject it with four or five ounces of warm boracic solution.

The patient should be lying down, with the head comfortably supported upon a pillow, the pelvis slightly raised, and the knees and hips flexed and rotated outward. The sound, of course, must be warmed and well lubricated, preferably with Lund's oil.

In sounding a bladder a definite plan should be followed. The upper part and the sides are examined first, as the point emerges from the prostatic portion of the urethra, not forgetting that a calculus is sometimes held against the pubes, even when the patient is lying down; then the handle is depressed, the beak inverted, and the floor and the pouch that exists in so many cases behind the prostate carefully felt all over. Rapid or rough movements must be strictly avoided: the former give rise to waves which may drive a light calculus away; the latter may injure the wall of the bladder. Digital examination of the rectum at the same time should never be omitted, particularly with children.

The contact of the sound with the stone must be heard as well as felt, and an attempt should be made to ascertain further details. Sometimes the material of which the stone is composed may be conjectured from the character of the sound it gives when struck. If it is oxalate of lime, the ring is clear, as against metal; if uric acid, it is more dull, like stone; if the outer crust is composed of triple phosphates, there is merely a rough, grating sound. In the same way a general idea may be gathered with regard to the size and number; but to obtain definite information, a lithotrite must be used, and even then, if, for example, the calculus is a very flat one, it is not always possible to be certain; one stone must be grasped first, its measurement taken, if possible, in more than one diameter, and then the instrument used as a sound to detect the presence of others. Besides this, the position and mobility of the stone, whether it is encysted or not; the state of the bladder as regards irritability, softness or hardness of the wall, whether it is smooth or covered over with rugæ; the size and prominence of the prostate; and the condition of the urethra, should all be noted. Very often the method of operation is determined to a large extent by some detail of this description.

Errors may arise in various ways. Not unfrequently a calculus is missed, even after repeated examination. There is too much fluid in the bladder, and the stone floats away before the sound; or too little, and it is enveloped in folds of mucous membrane. Sometimes the sound never reaches the bladder at all, but stops in the prostatic portion of the urethra or in the enlarged and dilated prostatic sinus. More often the stone is missed just at the neck, because the sound is not rotated soon enough after entering the bladder. Calculi lying in cysts are always difficult, owing to the very small size of the opening; and after lithotrity minute fragments covered over with a layer of coagulated blood may easily escape notice.

The opposite error, imagining that a calculus is present, is more serious. In children, in whom the wall of the bladder is very thin, the sacral promontory and the spine of the ischium, if struck smartly with a sound, give something of the same sensation, though the ring is not clear. A rough and fasciculated condition of the wall of the bladder, especially if the rugæ are coated over with phosphates, and tumors encrusted in the same manner, sometimes raise a momentary doubt; and the same thing may occur after lithotrity, when the bladder is being washed out, from the mucous membrane suddenly flapping with an audible click against the orifice of a large and straight evacuator.

The other methods of examining the bladder can only be regarded as accessories to the sound. The cystoscope, except in the case of a sacculated bladder, gives little or no further information.

With very few exceptions, calculi must be removed from the bladder by crushing or cutting; solution is rarely worth the trial. As the former is more common, and has to a great extent superseded the latter, it will be taken first.

## Lithotrity.

The modern operation owes its position to Bigelow, who, in 1878, recognizing the immense power of dilatation possessed by the urethra, and the ease with which the fragments of a calculus can be extracted by suction, proved that a stone could be crushed and removed, once for all, with far less risk than when the operation was repeated many times successively, and the bladder in the meanwhile left full

Fig. 439.—Bigelow's Lithotrite.

Full Size.

Fig. 440.—Thompson's Lithotrite.

of sharp, angular fragments, any one of which might become impacted at any moment.

Lithotrites for large calculi must be cut from a solid bar of steel; those for finishing the fragments may be forged. The principle is the same in all; a male blade gliding on a female one, and capable of being screwed down into it with immense force. The jaws are modified according to the kind of work; in the

larger instruments the female is pierced at the base, so that it cannot become clogged with debris, while the male is deeply cut into sharp-edged notches, so that the calculus may not slip; in the smaller ones both are solid and the surfaces are smoother. The male is narrower than the female, to avoid the risk of catching the mucous membrane. In one of the latest patterns (Reliquet's) the teeth of the female blade are directed transversely and obliquely, so that the calculus cannot slip toward the point when the male one comes down upon it; and the teeth of the latter, which act singly upon the stone, pass through the fenestræ of the female so as even to project beyond. The handle varies a good deal, but in all it is so contrived that while the male blade can glide up and down freely in the female for the purpose of seizing the calculus, it can be fixed at any point by simply touching a catch, and then can only be moved by the screw. The largest instruments, the end of which is prolonged into a kind of beak, are about the size of No. 28, French; the smallest, No. 15.

The other instruments required are a set of steel sounds, highly polished, for the purpose of dilating the urethra; evacuators, thin-walled metal tubes, straight, or curved like a catheter, varying in size from No. 15 or 18 to 32, French, each having a single large opening at or near the end, on the convexity or in the hollow of the bend, so as to suit all conditions, and an india-rubber aspirator (Fig. 443) which can be fitted on to the end of these by means of a short piece of flexible tubing. Various forms have been devised to prevent the entry of air, regulate the flow of liquid, and trap the fragments as they are sucked out. They are all filled from the top by means of a funnel closed with a stop-cock; some are fitted with a wire valve, which, however, is liable to become clogged; in others, the glass receiver, which should always be below the aspirator, is so placed that the fragments are conducted at once to the bottom, and the fluid drawn away from the top. Perhaps the most convenient, except that its connection with the tube is rigid, is the one described by Bigelow in the *Lancet* (January 6, 1883), as it can be filled with clean water without disconnecting.

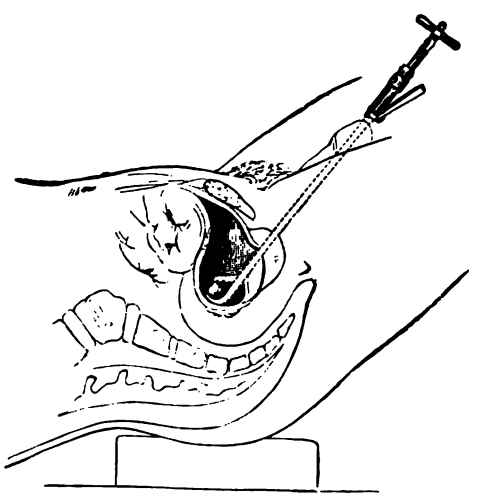


FIG. 441.—Operation of Lithotrity.

The rectum should be emptied the morning of the operation by means of an enema, and the patient placed under an anæsthetic. Cocaine may be used for small calculi if the patient is accustomed to the use of instruments. The pelvis should be slightly raised, and care should be taken that the chest and limbs are well covered up, as the operation may last a considerable time.

A steel sound is passed first to dilate the urethra and to ascertain its size. As a rule, an evacuator equal to No. 28 can be passed without difficulty, and sometimes even No. 32, though it may be necessary to slit the meatus down by the side of the frænum.

If the patient's bladder is not irritable and is known to contain a certain amount of urine, it may be left; but in most cases it is advisable to withdraw the contents, and inject four or five ounces of a warm antiseptic solution. The choice of lithotrite must be guided by the size and composition of the calculus. If it is large the instrument should be of proportionate strength and the jaws deeply cut, the female being fenestrated; if small or soft, such as a phosphatic concretion, a medium-sized one may be used from the first. If a sound passes

easily, it rarely happens that there is any difficulty in the introduction; the instrument must be warmed and oiled, and then allowed to slip down by its own weight, not letting it pass beyond the perpendicular until the beak has glided well below the pubes.

There are two methods of seizing the calculus. In the first the closed lithotrite is allowed to rest with the convexity upon the fundus of the bladder, and the male blade withdrawn (Fig. 441); very often, on pushing it down again, the stone is grasped at once, or, if not, is felt to slip to one side or the other, so that its position is known. In the other, the handle of the instrument is depressed until the beak occupies the centre of the bladder, the blades reversed, and the stone picked up from the floor (Fig. 442). The former answers for the first crushing; the other is the better when the prostate is enlarged, and when fragments have to be dealt with. The instrument, as it were, swings on a pivot formed by the fixed portion of the urethra; if it is steadily held, the fragments, as the stone is crushed, drop vertically down, and can be picked up again one by one with the minimum of manipulation.

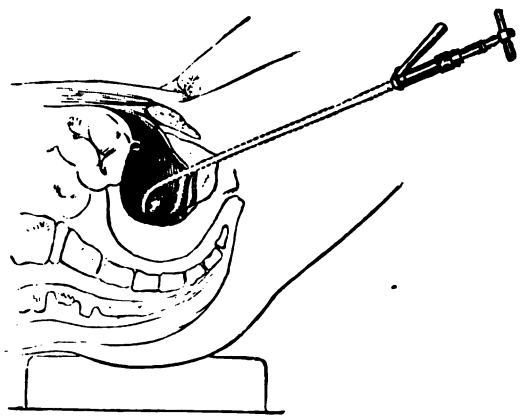


FIG. 442.—Operation of Lithotrity.

With soft phosphatic concretions the crushing can be effected by the hand; in other cases, as soon as the stone is grasped, the male blade is fixed with the catch, the instrument gently brought to the centre of the bladder so as to make certain that the mucous membrane is well out of the way, and the screw driven home until the calculus yields. If the fragments are large they may be crushed with the same lithotrite, but as soon as the bigger ones are disposed of a lighter instrument is better. Great care must be taken before it is withdrawn, that the male blade is well home, and that no debris is entangled in the jaws. Dragging out fragments of the calculus, tearing the mucous membrane of the urethra, is a most dangerous proceeding. A smart tap on the handle, or working the blade backward and forward, nearly always releases it. If possible, before the second lithotrite is removed, the calculus should be thoroughly crushed, so as to reduce the number of occasions on which an instrument is passed as much as possible.

FIG. 443.—Bigelow's Evacuator.

The evacuating tube should be the largest the urethra will admit without straining. Curved ones pass more easily, but Bigelow prefers them straight. If the fluid from the bladder does not at once rise up in the tube, it must be filled with a syringe, so that no air can enter; but a careful record must be kept as to the quantity. The aspirator introduces from one to three ounces more, and though the total will not nearly fill a healthy bladder, it is quite possible to tear the walls if they are thinned and softened from atrophy or fatty degeneration. On the

other hand, if there is too little (and occasionally a certain amount is lost when the instruments are changed), the mucous membrane may be sucked into the orifice of the tube and bruised. The injection should be slow, but the bulb quickly released, so that it expands rapidly, and the end of the tube should be moved gently about the fundus, especially if there is a post-prostatic pouch, to search the fragments out. Sudden stoppage of the current is due to the tube being accidentally withdrawn into the prostate, to the bladder becoming empty, or to the impaction of a large fragment in the eye. This can be recognized by the sharp, clear sound, and the sensation as it strikes against the side of the tube. When the calculus is large it is often necessary to withdraw the evacuator after some has been removed and re-introduce the lithotrite, but this should be avoided if possible.

At the end of the operation the bladder should be washed out with some clear fluid to make sure that no fragment is left. In the case of small calculi there is no bleeding, but with large ones and prolonged manipulation, especially where the veins are much dilated, it is scarcely possible to avoid it altogether. It is especially desirable to avoid leaving any fragment behind. The opprobrium of lithotrity is that the relief is not permanent—that recurrence takes place much more frequently than after lithotomy; and there is no doubt that it is to a great extent true. Sometimes the reappearance of calculi, as in the case of phosphatic concretions in old men with enlargement of the prostate, is due to entirely independent causes; but it must be admitted that occasionally small fragments are left (they may be passed subsequently by the patient) and form a fresh nucleus.

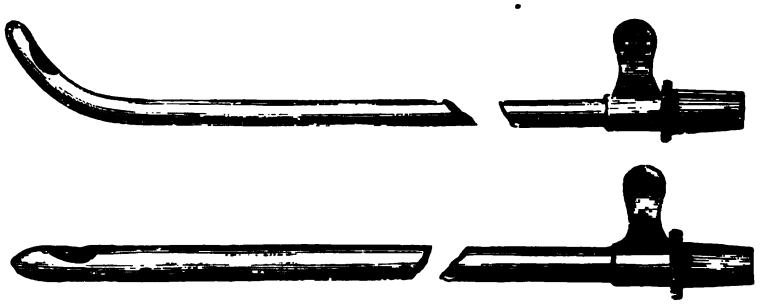


FIG. 444.—Evacuating Tubes.

**After-treatment.**—If the urine is acid and the bladder and kidneys sound, the after-treatment of the case is exceedingly simple. There is always a certain amount of irritation, owing to the prolonged manipulation; but, as the cause is removed, this soon subsides. The patient should be kept in bed for a day or two; a hot bath may be given at night; the diet should be light and unstimulating; and if there is much pain or tenesmus, or if retention is threatened, a few drops of a solution of morphia may be introduced just inside the neck of the bladder, or an opium suppository placed in the rectum. Unfortunately, when the urine is alkaline and the calculus phosphatic, and still more when the kidneys are diseased, even though the stone is softer and the amount of manipulation less, the risk of complications setting in, and of after-troubles, is very much increased.

Serious accidents may occur during the performance of lithotrity, without its being possible to allege undue violence. Hemorrhage is rarely of consequence, but in a few cases it has been excessive, probably from the rupture of a varicose vein filling the bladder with clot, and placing the patient in danger of septic decomposition and cystitis. The male blade may become so fixed that it is difficult to dislodge the fragment, and in one or two instances it has been necessary to open the bladder and free it before it could be withdrawn. Rupture of the bladder into the peritoneal cavity has occurred; and occasionally the urethra and the prostate are so bruised by the frequent passage and manipulation of very large instruments, that inflammation, and even suppuration, have followed. Impaction

of a fragment at the neck of the bladder, which used to be not uncommon, is scarcely ever met with under the present system.

**Complications.**—Lithotrity, like all other operations on the urinary organs, may be followed by consequences, some reflex, others inflammatory.

(*a*) *Reflex.*—The *shock* may be general and prove fatal, even when the kidneys are sound; or it may affect the vasomotor nerves of the kidneys, causing *partial or complete suppression* of urine; or the muscular wall of the bladder (*atony*). This last is especially frequent in the case of old men with enlargement of the prostate, in whom a certain amount of difficulty exists already. In addition *rigors* may occur, and *urethral fever* may set in acutely, or, more often, insidiously, associated with partial suppression, and ending in prostration and delirium.

(*b*) *Inflammatory.*—*Cystitis* is the most common. In many cases it exists already, but if it is recent, and the stone the only cause, it soon subsides. When the walls of the bladder are rough and irregular, covered with sacculi, and lined with a thickened or ulcerated mucous membrane—such a condition as commonly occurs in old cases of cystitis associated with enlarged prostate—the risk is very different. If decomposition of the urine sets in, the inflammation at once becomes intense; the mixture of mucus and blood with ammoniacal urine, kept at the temperature of the body, becomes offensive to the last degree; and unless free exit is given at once, either the patient dies of septic absorption from the putrid mass, or the inflammation spreads to the ureters and ends in acute pyelonephritis.

Inflammation may also occur *in or around the prostate* and at the neck of the bladder, especially after the use of large tubes; *epididymitis* is not uncommon; *peritonitis* may be caused by direct extension; and, particularly when the large plexuses at the neck are bruised and injured, *phlebitis* may occur, and lead either to the *thrombosis of the veins* of the extremities or to general *pyæmia*.

In all cases of chronic cystitis there is great risk of recurrence; possibly minute fragments of the original calculus are left embedded in the mucus; possibly fresh concretions are formed from the accumulation of phosphates on the walls; and in all such cases crushing often has to be repeated at intervals of a few years.

There are certain conditions in which the difficulty of performing lithotrity is so great, or the after-consequences so serious, that it is advisable to select some other method.

1. *Age.*—It has been shown by Keegan and others that lithotrity may be performed with perfect safety in children only three and four years old. The meatus is almost uniformly too small, but the urethra will usually admit a No. 13 French lithotrite and evacuating tube, and with this it is possible in a reasonable time to remove a uric acid or oxalate calculus of moderate size. In other respects, the small size of the prostate, for example, the healthy tone and condition of the walls of the bladder, and the state of the kidneys, children form exceptionally good subjects.

2. *Stricture.*—In ordinary cases this can be dilated or incised first; but where there is a large amount of inflammatory exudation, forming a dense mass in the perineum, suppuration with urinary abscess is not unlikely.

3. *Enlargement of the prostate*, without atony or cystitis, is of little consequence; the only difficulty is that of picking up the stone and the fragments from the pouch that forms behind; sometimes this can be facilitated by moderate distention of the rectum.

4. Similarly, *atony of the bladder*, without cystitis, does not preclude crushing, so long as the condition is recognized. The danger is that it sometimes occurs unexpectedly, and that a quantity of fluid in a state of putrefaction is left stagnant in the bladder.

5. *Cystitis.*—Where it is slight, caused by the calculus itself, and there is no permanent change in the wall, cystitis is not serious. On the other hand, if the urine is ammoniacal and deposits large quantities of ropy mucus; if the walls are fasciculated, and the lining membrane softened and coated over with a mixture of mucus and phosphates, the question becomes grave. Such a condition is always

associated with disease of the kidneys, and if serious consequences do not arise from this, the inflammation about the bladder is almost sure to be made worse, and perhaps become diffuse; suppuration may occur around the prostate; or peritonitis set in, especially if there are sacculi; or the inflammation may extend up the ureters and cause acute septic pyelonephritis.

6. *The Condition of the Kidneys.*—When they are diseased, any operation about the urinary tract is liable to be followed by partial or complete suppression of urine, urinary fever, or diffuse inflammation and even sloughing; and there is no doubt that lithotrity is especially exposed to these dangers; the only point is whether, in this respect, it is in any degree worse than lithotomy.

7. Lithotrity may be impossible owing to the size and hardness of the stone. Calculi of over three ounces in weight have been removed by crushing, the sitting lasting as long as four hours; but, as a rule, if composed of unmixed oxalate of lime, it is very difficult to crush one that measures an inch in diameter. The same thing may happen from the position of the stone. A calculus lying in a sacculus, or embedded in a cavity it has worked out for itself, often cannot be crushed. It is true that no operation can boast of much success under such conditions, but lithotrity is especially bad; the wall of the cyst is exceedingly thin; as the cavity cannot be emptied, it is left full of the debris; septic cystitis is almost certain to follow, and peritonitis or even sloughing of the wall may occur.

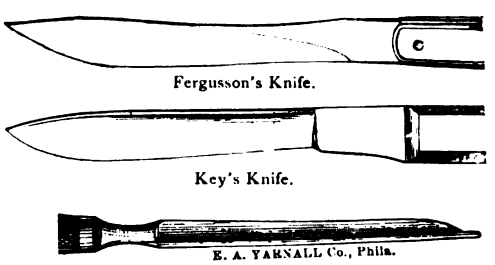
When the calculus is tightly grasped, so that it cannot be dislodged without using excessive force, if the patient is an old man it is better to leave it alone.

## Lithotomy.

The bladder may be approached either through the perineum or above the pubes. In exceptional cases calculi have been removed through the vagina and the rectum. The patient should be prepared in the same way as for lithotrity—a purgative given the day before and an enema the morning of the operation.

### Perineal Lithotomy.

*Lateral Lithotomy.*—The deep incision carried through the membranous and prostatic portions of the urethra into the left lobe of the prostate. The instruments required are a sound; a grooved staff, either straight or curved; lithotomy tapes, anklets, or Clover's crutch for fastening up the patient; a lithotomy knife, or broad-bladed, straight-backed scalpel; various kinds of forceps and a scoop. A catheter and a syringe for injecting the bladder, or washing it out after the operation; a blunt-pointed gorget, when the perineum is too deep, or the prostrate too large for the finger to enter the bladder; and a petticoated tube, or india-rubber tampon, in case of deep hemorrhage, may be required as well.




Fergusson's Knife.

Key's Knife.

Straight Probe-pointed Knife.

FIG. 445.—Lithotomy Knives.

The table should be narrow and of a convenient height, so that the operator has not to raise his hands too much. If Clover's crutch is used, the anklets and the strap may be placed in position while the anæsthetic is being given. It consists of a metal bar to place between the legs, with a semicircular padded crutch at either end. The legs are flexed upon the thighs; the bar, which is provided with a sliding rod fixed by means of a screw at any required length, placed between them; and the anklets fastened round the limbs, immediately below the knee. The thighs are bent upon the abdomen; a soft leather strap passed behind the

shoulders, and the free ends buckled to the crutches, so that when it is tightened up the limbs are absolutely fixed. Then the knees are separated to any extent by the sliding rod. If bandages or tapes are used, the patient's hands must be made to grasp the soles of the feet, the bandage being fixed first by a clove-hitch round the wrist, and carried round hand and foot together in a figure-of-eight.

The staff may be introduced either before or after the patient is tied. The former is the easier, but care must be taken in moving the limbs that the point is not driven through the wall. It is absolutely essential that the stone should be felt with it before the operation is commenced, and it is a wise precaution for one of the assistants to feel it as well. If the patient has not passed water recently, and the bladder appears to contain sufficient, there is no need to pass a catheter; but when there is any doubt it is as well to empty it, and replace the urine by six or eight ounces of some warm antiseptic fluid.

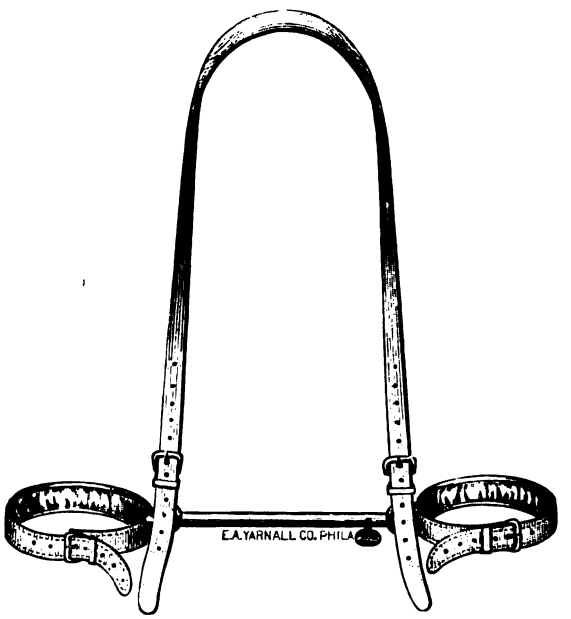



FIG. 446.—Clover's Crutch.

The patient is brought to the edge of the table, so that the nates project slightly over it, the limbs fixed in position, the perineum shaved, and the staff given to a third assistant to hold. If it is a curved one, it should at first be slanted a little toward the abdomen, and gently pressed down in the perineum, to bring the

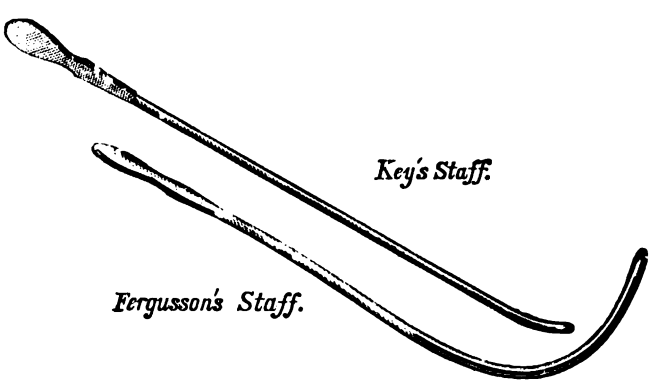



FIG. 447.

membranous portion of the urethra toward the surface; as soon as the groove is felt, it should be raised to a vertical position, and pulled well up under the pubes for the deep incisions. The shaft should be grasped firmly with the fingers, and the ball of the thumb pressed against the flat part of the handle. If the staff is straight, it is held well up with the handle pointing slightly toward the operator, until he takes it himself.

Before beginning, the forefinger is introduced into the rectum to feel the

prostate, to make sure the rectum is empty and the staff in its proper place, and stimulate the gut to contract out of the way. Then, steadying the skin with the left hand, an incision is made from a point midway between the scrotum and the anus, commencing close to, but not at, the middle line, downward and outward for about three inches (in an adult) to a point nearer the ischial tuberosity than the anus. This divides skin, superficial fascia, subcutaneous fat, external hemorrhoidal vessels (which may bleed freely for a moment), and perhaps the superficial perineal vessels and nerves. The incision is then deepened by dividing the transversus perinei muscle, with the artery upon it and the lower border of the triangular ligament, the forefinger guarding the rectum in the wound. The bulb should not be touched, though the fibres of the accelerator urinæ may be exposed and even divided.

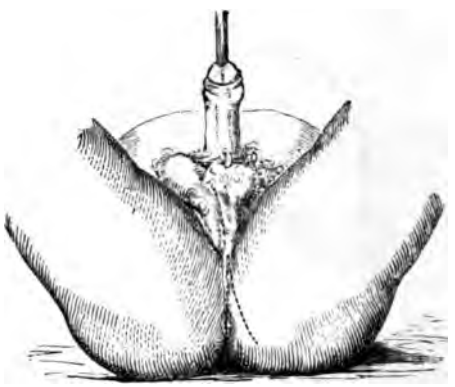


FIG. 448.—The Incision for Lateral Lithotomy.

The finger is then pressed into the upper angle of the wound, to feel for the staff, and the knife passed along it until the point is lodged in the groove. The staff is then raised to the vertical position and hooked well up; and the knife, with the edge turned toward the tuberosity, is carried forward in the groove until it is stopped at the end, dividing as it goes the compressor urethræ and the membranous portion of the urethra, the deep layer of the triangular ligament, the left lobe of the prostate, some of the fibres of the levator prostatæ, and the ring at the neck of the bladder; the incision, of course, not being deeper than the blade.

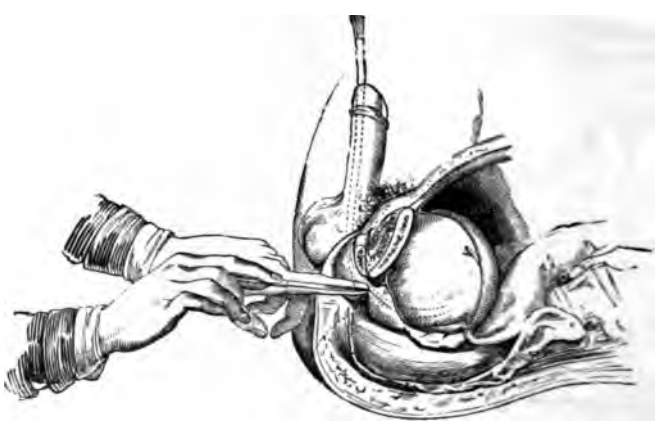


FIG. 449.—Lithotomy with the Curved Staff.

It is then withdrawn, the edge still pointing toward the right, so that it faces the longest diameter of the prostate, and as it comes, being gently drawn downward and outward, to enlarge the incision on the under surface of the gland. The fibrous ring at the neck of the bladder is notched so that it yields readily; in doing this the plexus of veins may be laid open, and in old people they are not unlikely to bleed profusely; but, if the cut is not deeper than this, there is no fear of infiltration of urine.

If the incision is too small, the tissues are so bruised in the process of extrac-

tion that diffuse inflammation is very likely to follow. If it is too large, passing through the plexus into the recto-vesical fascia and dividing the lateral true ligament of the bladder, urine is almost certain to be extravasated into the deep cellular tissue. The staff must be held well up against the pubes, the point of the knife not allowed to leave the groove, and the blade kept in a line with the staff, except in withdrawing it quite at the end. If this is carried out, it is almost im-

FIG. 450.—Lateral Lithotomy with Key's Straight Staff.

possible to wound the floor of the bladder, and the incision is sufficiently large to admit the finger with a little gentle pressure. When the calculus is left, if it is thought that there is not sufficient space, it is easy to divide anything that resists with a probe-pointed bistoury.

With a straight staff the process is slightly different; the preliminary steps are the same, but as soon as the point of the knife is placed well in the groove, the

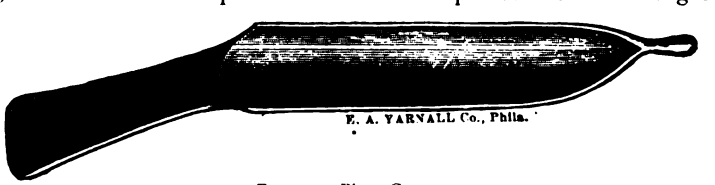



FIG. 451.—Blunt Gorget.

operator takes the staff himself with the left hand, lowers it until it is nearly horizontal, holding the point of the knife meanwhile quite still, and then, turning staff and knife together on their long axis, so that the latter is in the proper plane, pushes it on until the resistance of the prostate is no longer felt. The extent to which the gland is divided depends upon the angle formed by the knife with the staff. With a straight instrument used in this way as a director, it is much more

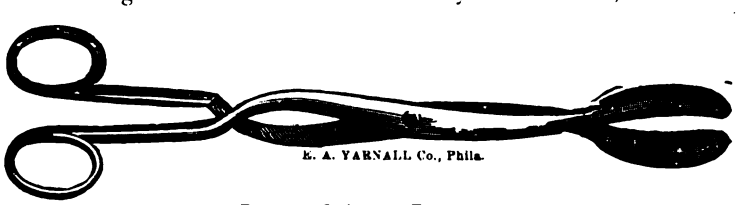



FIG. 452.—Lithotomy Forceps.

easy to keep the knife in the groove and to make an incision sufficiently free without being too wide.

As soon as the knife is withdrawn the finger is gently worked down the groove without using force, dilating the tissues until it enters the bladder and feels the calculus. Then, and as a rule not till then, the staff may be removed. In the case of very deep perineum or very large prostate, where the finger is too short to reach the bladder, a blunt gorget may be passed along the groove to open up

the route for the forceps; or a director may be used to keep the line of the urethra and act as a guide after the staff has been withdrawn. As soon as the finger feels the stone, a suitable pair of forceps, warmed, must be guided through the wound into the bladder, and the blades gently separated. Withdrawing the finger is followed by a gush of urine which may carry the calculus at once into the grasp of the forceps, or a slight movement of the blades may enable it to be seized; but often this is the most difficult part of the operation. The blades should be opened laterally, and the lower one made to sweep along the floor; if this fails, the stone may be caught behind the prostate or above the pubes, and the forceps must be withdrawn to the neck, and the handles raised or lowered. Sometimes the difficulty arises from the size of the calculus or from its shape, and it may be necessary to remove the forceps and introduce a larger pair, or to manipulate the stone with the finger so that it may be caught in another diameter. If it breaks up, it must be extracted with the finger and a scoop, washing the bladder out afterward to remove the debris. Everything must be done slowly, gently, and methodically; the direction of the forceps must be in the axis of the pelvis; the traction must be straight, without rotation; if there is much resistance, the tissues in front of the stone must be felt with the finger; sometimes they can be gently pushed off it; or they may be notched with a scalpel; or if the obstruction can be felt all round, and it is clear that the incision is too small, the forceps may be removed, the stone allowed to drop back, and the tissues that resist divided, as far as is prudent, with a probe-pointed bistoury, using the finger as a guide. By this means, in an adult, a stone an inch and a half in diameter may be removed without dividing the lateral ligaments and without too much bruising; one two inches across may possibly be extracted by drawing it well down and carefully dividing the tissues that resist, or incising the other side of the prostate; but in such a case it

FIG. 453.—Lithotomy Scoop and Director.

is better either to perform the suprapubic operation, or to crush the calculus first and then extract the fragments. Under no conditions may the incision be made first, and then the stone broken up by instruments introduced through the wound. The fracture of a calculus, even when held in the forceps, adds materially to the risk, owing to the necessity of washing out the bladder to get rid of the fragments.

The last step in the operation is to explore the bladder with the finger, to make sure there is no other calculus present.

Unless hemorrhage is feared, there is no need to leave a tube in the wound. If the bladder and kidneys are sound, it is quite possible, especially in children, to secure union by the first intention, which this, of course, would prevent. As a rule, the urine flows away through the opening for the first two days, and then, owing to the swelling about the prostate, some, and occasionally all, comes by the urethra. If suppuration begins it pours out of the wound, the amount gradually diminishing as healing progresses. The patient should be placed in bed, on his back, on a divided mattress protected by a waterproof. The hips and knees should be bent and the legs supported by pillows. Dry sponges wrung out of carbolic solution and frequently changed, or wood-wool, may be used to absorb the urine and the discharges of the wound. Every endeavor must be made to keep the skin dry and to prevent excoriations; especially in old people, and where the urine is ammoniacal, this sometimes gives a great deal of trouble. Occasionally the wound becomes coated over with phosphates, and it may require to be washed out.

The diet should be simple but good. The question of stimulants must be determined by the habits of the patient and the condition of the pulse. The bowels may be opened on the third or fourth day by a gentle aperient, aided by an enema; and as soon as the wound is closing and there is no further risk of hem-

### Accidents.

1. *Hemorrhage.*—The transverse perineal and external hemorrhoidal arteries are rarely of consequence; if they continue bleeding, pressure forceps may be placed upon them until the end of the operation. The artery to the bulb may be wounded either from its taking an abnormal course, or from the incision being commenced too far forward, but it seldom causes any difficulty. Sometimes the bulb itself is injured in the same way. Profuse arterial hemorrhage occasionally comes from some deep-seated trunk, possibly the internal pudic, though this is very well guarded under the lip of the tuberosity; if the vessel cannot be found and tied, forcipressure, acupressure, or even digital compression by relays of dressers, must be kept up for twenty-four hours.

Venous hemorrhage may be profuse at the time, or may come on later, and the blood may collect in the bladder and distend it before the occurrence is known. The coagula must be washed out, the bleeding checked by cold and exposure to air; and if this does not succeed, or if it recurs after a few hours, the wound must be plugged. The best instrument for this purpose is Buckston Browne's dilatable tampon—a central tube, so that the urine has free exit, surrounded with a soft india-rubber sac which can be introduced when collapsed, and distended with air or water. A flexible tube should be attached, to conduct the urine at once to a vessel beneath the bed; but it must be recollected that plugging the wound assists absorption from the surface and exerts very injurious pressure upon the soft tissues.

2. *Wound of the rectum* may occur, especially in old people, in whom the lower end is often much dilated. It may be cut, owing to the knife not being sufficiently turned to one side, or it may slough from bruising. Generally the opening closes of itself, but it may leave a fistula.

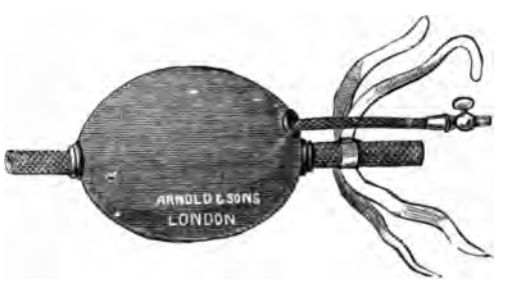



Fig. 454.—Buckston Browne's Dilatable Tampon.

3. *The posterior wall of the bladder* has been punctured by the staff and by the knife leaving the groove and being carried in too far; and the urethra has been missed altogether, the knife passing by the side of it or behind it, and entering the bladder through the floor, or even behind the prostate.

4. *Tearing the urethra* across may occur in children. It arises from the deep incision being too small. The tissues are very delicate and easily give way; the bladder lies higher and is less flexed than it is later in life, and if an attempt is made to force the finger down the urethra, it is very easy to tear it across and push everything onward until a cavity that feels like the bladder is formed in the tissues at the neck. In some of these cases the deception has been increased by the stone being felt through the wall. If the accident is recognized in time, the finger should be withdrawn, and the knife carefully pushed along the groove until the bladder is really opened; but if the bladder is pushed off the staff so far that it cannot be brought down again, either the operation must be abandoned, or, as this is practically fatal, the suprapubic operation must be performed, the stone extracted, and a catheter passed through the orifice of the urethra from the interior into the perineal wound.

To avoid this Heath recommends that, instead of trying to pass the finger along the staff, a director should be introduced into the bladder first, the staff withdrawn, and the finger then gently worked along the upper surface of the director. In other cases a pair of polypus forceps may be introduced to dilate the urethra; but whatever plan is adopted, if there is much resistance, it is wiser to remove the finger and enlarge the incision.

The **prognosis** in lateral lithotomy depends upon:—

1. *Age.*—In children it is wonderfully successful, a series of seventy and eighty cases without a death having been published. As years advance it becomes steadily more and more fatal.

2. *The Size of the Calculus.*—Up to an inch in diameter this is not material; over this, the mortality increases rapidly, and in very large calculi the operation is exceedingly dangerous.

3. *The State of the Kidneys.*—This is the most important of the three. Most of the fatal cases may be traced to urinary fever with suppression, or to diffuse inflammation and exhaustion, consequent on renal disease.

**Causes of Death.**—1. *Septicæmia.*—All the structures around the wound are torn and crushed; there is a certain amount of decomposing urine, and the tissues, if the kidneys are diseased, break down and slough at once. It generally begins about the second or third day; there may be a rigor with high fever, acute cellulitis, and distention of the abdomen; or the beginning may be insidious with little or no pain, but with dryness of the mouth and tongue, hiccough, and extreme prostration. It is nearly always fatal, but recovery with the formation of pelvic abscesses has been known.

2. *Urinary fever* may be acute and fatal within forty-eight hours from suppression of urine; more often it is chronic, and associated in such a way with septicæmia that it is impossible to assign to each its share. It rarely occurs when the kidneys are sound, but it is a common cause of death where they are only just able to hold their own, as in old cases of calculous disease and chronic cystitis. Suppurative pyelonephritis sets in from extension of the inflammation up the ureters; multiple abscesses form in the cortex; the secretion of urine becomes still further diminished, and the patient dies with symptoms of low fever and prostration.

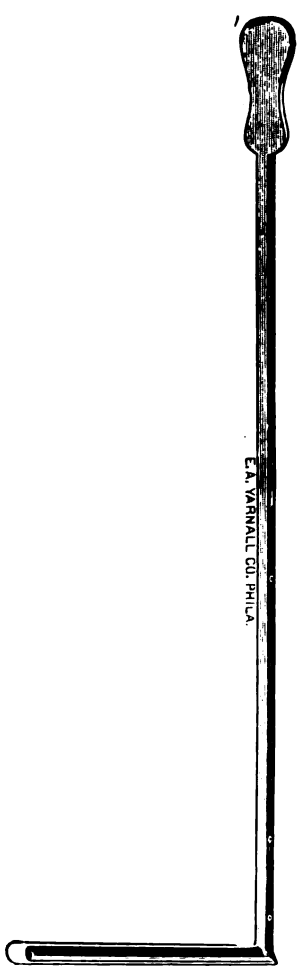



FIG. 455.—Angular Staff.

3. *Extravasation of urine* into the cellular tissue at the base of the bladder, owing to the neck having been laid open and the recto-vesical fascia divided. Brodie saved one case in which this had occurred by laying the whole perineum open into the rectum. Usually it is fatal within the first few days from acute peritonitis.

4. *Hemorrhage*, not so much from the loss of blood at the time as from the weakened state in which the patient is left.

5. *Phlebitis and pyæmia.*

6. *Peritonitis* from wound of the posterior wall of the bladder, sloughing of a sacculus, or extension from the cellular tissue.

7. *Shock and exhaustion.*

Difficulties may arise in lateral lithotomy, either from anatomical causes, or from the size, position, and shape of the calculus. The former include false passages in the urethra, enlargement of the prostate, unusual depth of perineum, contraction of the pelvis from rickets, and such occasional obstacles as tumors growing from the bones, and ankylosis of the hip joint. These may usually be overcome by the exercise of a certain amount of ingenuity. The size and shape of the stone may, however, be such as to render the operation impracticable. It is difficult to say what size of stone has not been removed through a lateral incision; but at

the present time no one would willingly attempt the extraction of one two inches in diameter, and it is better to adopt other methods for all over an inch. The position of the stone is scarcely less important. When it is deeply imbedded in a sac that it has worn for itself, it may be dislodged either by the finger in the rectum, or by inserting the nail beneath it, and gradually working it out, or even by very carefully notching the edges of the sphincter-like ring that holds it fixed; and this, it must be admitted, cannot be done by lithotrity; but when the stone is lying in a large thin-walled sacculus, the orifice of which is at some distance from the neck, and very likely is only sufficiently large to admit a quill pen, it cannot be removed. If a small tube can be introduced through the perineal wound, some relief may be obtained by draining the sacculus, but there is no means of extracting the stone.

*Median Lithotomy.*—In this the deep incision extends only through the membranous portion of the urethra and the apex of the prostate.

The patient is prepared for operation in the same way, and placed in the same position, but the staff used is rectangular, so as to bring the apex of the prostate as near the surface as possible. The forefinger of the left hand is placed in the rectum, and either an incision made in the middle line, or a straight-backed bistoury, with the edge toward the pubes, pushed at once through the perineum to the angle of the staff. Whichever plan is adopted, the incision must be exactly median, commencing below the bulb, stopping short of the rectum, and laying open the membranous part of the urethra and the commencement of the prostatic. A director is then passed along the groove into the bladder, the staff withdrawn, and the forefinger insinuated along the urethra, following the upper surface, because the roof is more firmly fixed than the floor, and there is less danger of tearing it across. In this way the prostate is gradually dilated, until the finger gains the interior of the bladder. There is a certain amount of bruising, and possibly rupture of the gland tissue and muscular fibre beneath the mucous membrane; but, so far as the adult is concerned, there is no extensive laceration (a similar operation is often performed merely for exploration), and rupture of the capsule or of the recto-vesical fascia is impossible. The operation is then completed in the ordinary manner.

### *Comparison of Lateral and Median Lithotomy.*

The chief advantages possessed by the median are—

(*a*) Less risk of hemorrhage. Abnormal arteries cannot be divided, and the prostatic plexus is not opened.

(*b*) It is impossible to injure the recto-vesical fascia. In the lateral operation the knife runs along the groove of the staff, cutting the prostate and the neck of the bladder; so long as the incision is only the depth of the blade, which is quite sufficient to allow the finger to pass into the bladder without forcing it in the least, the lateral true ligaments and the pelvic cellular tissue are entirely out of danger; but if the knife is not kept parallel to the staff, especially when the deepest part of the incision is being made, or if the surgeon allows his hand to drop too much, it is very easy to carry the incision right through the gland and the prostatic plexus. In the median operation this is impossible; the incision goes no further than the apex of the prostate, and the finger cannot tear the fascia.

(*c*) After the operation the urine very soon ceases to flow out of the wound, and the patient is saved much discomfort.

The disadvantages are—

(*a*) Want of space, not only for the superficial, but for the deep incision; so that a calculus more than an inch in diameter cannot be extracted. To obviate this Harrison recommends that an incision should be made with a probe-pointed bistoury along the floor of the prostatic urethra, from within outward; and that then the two sides of the prostate should be torn asunder by the pressure of the index finger.

(*b*) In children particularly there is the danger of tearing the urethra across.

(*c*) The bulb and the rectum are both more likely to be wounded.

Median lithotomy can only be performed when the calculus is small, and is seldom selected unless there is some condition which either precludes crushing or renders it inadvisable. The following are the chief:—

1. Dense cartilaginous stricture, involving the membranous or the posterior portion of the bulbous portion of the urethra. This may be incised at the same time.

2. Enlargement of the prostate, in which it is thought that either a portion of the gland may be removed with advantage, or the post-prostatic pouch drained.

3. When there is a foreign body of peculiar shape.

4. When there is a number of calculi, too large to come away in an ordinary evacuating tube, and too many to be crushed.

5. When there is a calculus or a fragment impacted at the neck of the bladder, or in the prostate, or in the orifice of one of the ureters, endangering the safety of the kidney.

6. As an adjunct to lithotrity, after the stone has been crushed, where it is desired to evacuate the fragments at once or to drain the bladder.

### Suprapubic Lithotrity.

In this the bladder is opened over the pubic symphysis, below the peritoneum.

When the bladder is empty the fold of the peritoneum lies below the upper border of the pubic symphysis; in moderate distention it rises to the same level, and in some people it may be half, or even three-quarters of an inch above, but it is only in cases of chronic retention that the space is of any size. According to Garson this is mainly due to the bladder stretching backward into the hollow of the sacrum and compressing the rectum, instead of rising up out of the pelvis; and if this is prevented by filling the intestine to a very moderate extent, the fold of the peritoneum may be raised (especially in fat people) sufficiently for all surgical purposes. There is no strain upon the wall of the bladder; its anterior surface is well exposed; and the floor is raised and fixed, so that it is much more easy to introduce sutures if they are required.

In children the fold of the peritoneum is higher; when the bladder is moderately full it is nearly always well above the level of the bone; in distention there may be two inches, and even more.

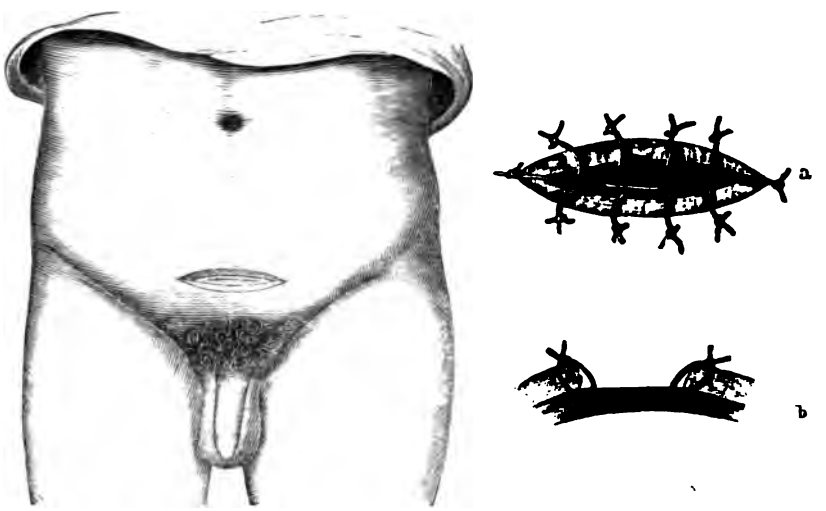
The preparation of the patient is the same, but the position is the ordinary recumbent one, with the hips slightly flexed. A very thin cylindrical rubber bag, made without seams, and capable of holding twelve ounces, is introduced into the rectum well above the sphincter, and connected with an irrigating can filled with warm water. Distention in this way is more equable than with a syringe, and the tube can be clamped or unclamped at any time. Ten ounces are usually ample, even in an old person; and less than this is advisable for a young adult; the mucous membrane of the rectum has been severely injured on several occasions by bags of unsuitable shape or size. A soft catheter should then be passed, the bladder washed out with a warm antiseptic solution, and the end of the catheter connected by a flexible tube with a vessel filled with the same. By raising or lowering this, as occasion requires, the bladder may be filled to any desired extent, or emptied, without the necessity of tying anything round the penis. This method of distention is much to be preferred, both in the case of the rectum and bladder. It is gradual and perfectly even; it can be regulated to a nicety, and can be relieved at once by lowering the vessel.

The pubes must be shaved, and an incision three or four inches in length made exactly in the middle line, commencing just below the upper margin of the symphysis. The sheath of the rectus is exposed first, and carefully divided upon a director; then the layer of the transversalis fascia that bounds the prevesical space in front; the posterior one should prevent the peritoneum being seen, but if

it comes into view it must be pushed up out of the way with the finger. In the case of very large calculi it may be necessary to divide the tendon on either side, but this should be done as little as possible.

If the vessel connected with the catheter is raised a little, the bladder slowly presents itself covered over with a layer of soft, delicate fat (sometimes of considerable thickness), containing numerous tortuous veins. It is essential to interfere with this as little as possible; the handle of a scalpel, or an ivory separator, as Thompson recommends, may be used to push it to one side; one of the chief risks is the infiltration of urine, and this is almost sure to follow if there is any rough handling or hemorrhage. In most cases there are two large veins running down the anterior surface of the bladder in a vertical direction; and the greatest care is needed to avoid not only these but the smaller ones near the neck.

One way of securing the bladder, so that it does not collapse when opened, is to pass two sutures through the muscular coat, one on either side; but a sharp hook or toothed forceps is usually preferred. The opening itself should be made with a scalpel (the edge pointing toward the pubes) in the middle line between




Showing the Incision through the Skin. (*Bardenheuer.*) *a*. Plate showing the Bladder Stitched to the margin of the wound. *b*. Appearance on Section.

FIG. 456.—Suprapubic Lithotrity.

the veins, and it should be large enough to admit the finger. The calculus must be dealt with according to its size and position. Sometimes it can be extracted by the finger and a scoop, or with the two fore-fingers; in other cases polypus forceps, or lithotomy forceps, may be used to lay hold of it; even small midwifery forceps have been employed; and in one instance it was necessary to break up the calculus with chisel and mallet. One disadvantage of rectal distention is that the stone, owing to the way in which the centre of the floor of the bladder is elevated, is apt to roll down to the sides. This, however, is of little importance, as the whole interior can be easily explored.

The treatment of the wound must be guided by the condition of the urine and of the walls of the bladder. In children and young adults, if the kidneys are sound, and the muscular coat fairly healthy and not much bruised, an attempt should be made to secure union by the first intention. Two series of sutures may be used—one through the muscular coat to bring the edges together; the other, Lembert's, outside this; but neither should touch the mucous membrane, and the latter should extend not only the whole length of the wound, but for a little distance beyond at either end. Either silk or chromic catgut may be used. In any

case the sutures must not be more than an eighth of an inch apart, or when the bladder becomes distended leakage will take place between them. Even if they do give way after twenty-four or forty-eight hours, the risk of urinary extravasation is by that time much diminished, and in a fair proportion of the cases the wound has healed up at once. If, however, the walls are thinned or fasciculated, if they have been bruised, if the urine is ammoniacal, or the kidneys diseased, union by the first intention is so problematical that it is wiser not to try. The wound in the bladder should be left entirely open, the abdominal one, if it is very long, being closed, so far at least as the upper extremity is concerned.

If the wound of the bladder is sutured, morphia is usually advisable. Suppositories may be used, but it is better injected directly into the tissues over the pubes. If there is any doubt about the condition of the sutures a catheter may be passed as often as required; with cocaine there is rarely any objection, but, especially in the case of children, it should be avoided if possible. Tying a catheter in it is not merely useless, but a constant source of irritation; and draining through the perineum, though it may be sometimes advisable to prevent decomposition after the removal of tumors of the bladder, is rarely needed in lithotomy.

If the wound is not secured, an attempt must be made to keep the bladder as dry as possible. In his earlier cases Thompson recommended that the patient should simply lie on his side, changing from one to the other every six hours so as to prevent excoriation. Trendelenburg tried the prone position, but this is scarcely practicable in the cases which require it most. The simplest plan is to introduce a full-sized tube, and thread it with loosely-packed lampwick for about a foot of its length, so that it will act as a siphon. If this fails, an apparatus like a Higginson's syringe may be attached to it by a side branch, and the contents aspirated at frequent intervals either by the patient or the nurse. Greig Smith does not consider a drainage tube necessary if absorbent dressings are used and changed at frequent intervals; the bladder is kept empty by the pressure of the viscera above it.

Compared with the perineal methods, the accidents that may occur in the course of suprapubic lithotomy are exceedingly few and easily avoided. The rectum and bladder have been ruptured from excessive dilatation, and inflammation of the mucous membrane of the former has been caused by the pressure. The peritoneum has been opened, so that the operation had to be delayed: and free hemorrhage may occur from the prevesical plexus. This, however, is important rather from the facility that it gives to subsequent suppuration and extravasation of urine than from actual loss of blood.

**Causes of Death.**—In children this operation is as successful as lateral lithotomy. In adults the comparison is hardly fair, as many of the cases were such that the lateral operation was impossible.

Suppurative pyelonephritis, with partial suppression, is the most common. It generally proves fatal in the course of a few days, with low muttering delirium and extreme prostration.

Pericystitis, extending into the cavity of the pelvis and setting up pelvic cellulitis and peritonitis, may occur from injury to the soft tissues around the bladder or from extravasation of urine. Its course and severity depend largely upon the condition of the kidneys; in children, for instance, it very rarely occurs.

Besides these, death may occur from shock, exhaustion, pyæmia, or other sequelæ common to all operations in such conditions.

### Choice of Method.

Three things have to be taken into consideration in selecting a method: the patient, the urinary organs, and the calculus.

1. *The Patient.*—Under six years of age, crushing is not advisable. It has been done in younger patients, and occasionally the urethra is sufficiently capa-

Between six and puberty, crushing and cutting (for all moderate-sized stones) are equally successful. Unless there is some other condition, the choice is perfectly open. After puberty, so far as years alone are concerned, there is no question that the former is to be preferred.

2. *The Urinary Organs.—The Urethra.*—The presence of a stricture or false passage does not preclude lithotrity, but it is an objection; if there is much inflammatory exudation around, suppuration and urinary abscess are not unlikely. Enlargement of the prostate in the same way, so long as it is moderate, does not prevent crushing, though it renders it difficult; but when it is excessive, or very irregular, with a deep post-prostatic pouch, the suprapubic method is better.

*The State of the Bladder.*—Atony of itself does not prevent lithotrity, or make the operation difficult; the trouble comes afterward from the constant washing out that is required. It must be remembered that sometimes it is advisable, on account of the atony, to make an opening in the bladder and drain it thoroughly.

The same may be said of cystitis. If it is slight and due to the calculus, it will be made perhaps a little more severe by the crushing, but, the cause being removed, the inflammation soon subsides. When, however, the cystitis has already lasted some time, and the walls are irregular or the urine ammoniacal, it is necessary to take other things into consideration. If the kidneys are sound (which they seldom are) and the urethra tolerant, the calculus may be crushed and the bladder washed out periodically, to clear away the decomposing mucus from the walls and stop the fermentation; but in many of these cases it is wiser to drain the bladder through an opening in the perineum, and, if this is done, it is as well at the same time to extract either the calculus itself, if it is small, or the fragments into which it has been broken by a few minutes' crushing. This combination of crushing with the median operation is exceedingly useful; the operation is not a long one, the shock is not severe, the bladder can be thoroughly emptied, and it enjoys perfect rest afterward, the urine being drained off directly by means of a flexible tube carried outside the bed.

If the presence of sacculi can be diagnosed, crushing should not be attempted. Most of the cases of peritonitis are caused in this way.

*The State of the Kidneys.*—When these are diseased it is still a question whether lithotomy or lithotrity is the worse. Much depends upon the calculus, but probably a great deal more upon the operator. If the stone is only of moderate size and soft, and if the crushing is done by a practiced hand, rapidly and gently, with the minimum of manipulation and without any bruising, the risk is very much less than in any cutting operation; but, on the other hand, if the stone is of unusual size or hardness, if the condition of the bladder is such that fragments are likely to remain behind in the mucus, or to require a great deal of manipulation, it is probable that the suprapubic or the combined operation is the better, as inflicting less injury.

3. *The Calculus.*—Calculi have been crushed up to four ounces in weight, but such are exceptional. As a rule, an oxalate of lime one over an inch in diameter, or one of uric acid over an inch and a half, is nearly as much as can be accomplished. For larger ones (unless they are very soft) the suprapubic operation alone is suitable. Besides the size of the calculus, however, its position, especially if it is fixed, and its shape, are of importance in determining the method of operation.

Sometimes there are other considerations present which prevent either crushing or cutting, and limit the choice, as, for example, deformity of the pelvis, tumors growing from the pubic bones, or from the prostate and bladder, ankylosis of the hip joint, etc.

Lithotrity, therefore, is not suited to children under six years of age; for calculi over a certain size (depending upon their composition), encysted stone, or in cases of dense stricture. Whether it should be preferred to other methods in cystitis, atony, great enlargement of the prostate and disease of the kidneys (all

of which frequently occur together), depends chiefly upon the operator. The stigma from which it suffers is the frequency of recurrence, even as much as one in seven or eight, in the most practiced hands.

As regards lithotomy, the suprapubic method is probably the easiest and the least dangerous in the hands of most operators, but it must still be regarded as to a certain extent the fashion of the day, and therefore upon its trial. For calculi over an inch and a half in diameter it is the only method, unless the stone is first broken into a few fragments and extracted by the median. Recovery is more slow after it than after the lateral or the median (except in children); it is almost as liable to be followed by urinary fistula; and drainage is certainly a difficulty, especially if there is cystitis; but there is no important structure near that can be injured if reasonable care is used, the space is less limited, there is no danger of hemorrhage, the incisions are more easy, the removal of the calculus is not attended with such difficulty, and the interior of the bladder can be explored more thoroughly. Sometimes other conditions, such as adhering masses of phosphates, can be dealt with at the same time.

### Calculus in the Female.

The anatomical conditions of the female bladder are such that calculus is much more rare, and is much easier of extraction than in the male; moreover, in them, the extreme form of cystitis, with fasciculated and sacculated walls, which results from stricture or enlarged prostate, and is always attended by disease of the kidneys, is practically unknown.

In adults the urethra may be dilated so as to admit the forefinger without risk of incontinence, so that small calculi can be extracted directly. If they are too large for this, a lithotrite may be used to break them up sufficiently; if larger still —and they have been known to be of enormous size—they may be extracted either through the vagina or by the suprapubic method. The latter is perhaps to be preferred, as the former, even when the incision is sewn up at once, exposes the patient to the risk of vesico-vaginal fistula. In children, in whom the sexual organs are not developed, and who seem not to suffer from infiltration of urine to the same extent as adults, the suprapubic is certainly the better method.

## TUMORS OF THE BLADDER.

Tumors of the bladder have a peculiar tendency to assume a papillomatous character, even when they are malignant. There are no papillæ in the mucous membrane, but it must be remembered that the bladder and allantois are developed in connection with each other, and that the fœtal villi are partially dependent upon the latter. There is a very close resemblance in external appearance, and even in structure, between some forms of vesical papilloma and the tufts that are found on the placenta.

### Papilloma.

In many cases the tumor is composed of nothing but these villi. When the bladder is empty there is a rounded, red, vascular mass lying on the mucous membrane, springing from its superficial layers, and freely movable on the subjacent tissue. As soon as it is placed in water a number of delicate, hair-like processes float out from it in all directions, like the tentacles of a sea anemone. Each contains a loop of a vessel, and outside this a delicate basement membrane upon which rests the columnar epithelium. In many there is no fibrous tissue at all; in the larger there may be a few threads running by the side of and surrounding the blood-vessels. These tumors are known as fimbriated papillomata; usually they are single and sessile, growing near the trigone, but they may be multiple and pedunculated. In exceptional cases the whole interior of the bladder is cov-

### Fibro-papilloma.

In these there is a greater amount of fibrous tissue; they are denser and firmer than the former, but they still belong mainly to the mucous membrane. In external appearance they are very similar, but the villi are usually shorter and less characteristic.

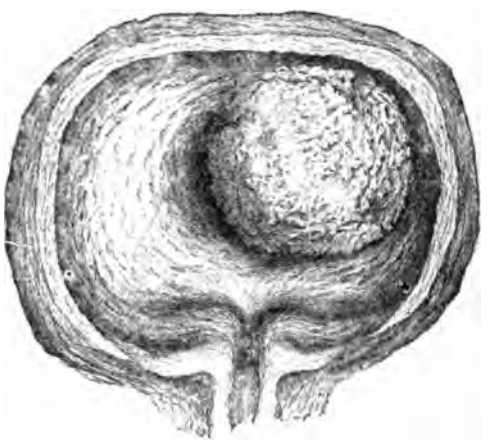


Fig. 457.—Fibro-papilloma of the Bladder.

### Fibroma.

Tumors consisting of fibrous tissue only are occasionally found in connection with the submucous coat. Usually they project as polypoid growths, with the unaltered mucous membrane stretched over them; but, as all other vesical tumors, they are occasionally covered with villi. In some there is a certain amount of unstriped muscular tissue, so that they are really fibro-myomata; and pure myoma has been described. In others (fibro-myxoma) some of the fibrous part has become converted into mucous tissue.

Sarcomata are more rare. In external appearance they resemble fibro-papillomata, but the fibrous tissue in the interior is replaced by sarcomatous elements, and their growth is much more rapid. In some instances, in which fibro-papillomata have recurred after removal, the secondary growths were softer and sprang up more quickly than the original, as if the fibrous part was giving way to a growth of less perfect type. In a few cases round-celled, spindle-celled, and even chondrifying sarcomata have been found.

### Mucous Polypi.

Outgrowths from the mucous membrane, resembling those that are met with in the nasal passages and in the rectum, are not uncommon, especially in children. Often they are multiple, and the pedicles occasionally become stretched to such an extent that in females they may even protrude at the meatus.

### Carcinoma.

Scirrhus and encephaloid are rare. Epithelioma, on the other hand, is the most common of all tumors. It is usually found after middle life, and it may occur at any part of the bladder. Nothing is known with regard to its cause; there is no reason to connect it with the irritation of calculi, catheters, or anything else. In general the tumor is single, but sometimes there is more than one, and occasionally they are very numerous. In a few instances, in which the growths have been on opposite sides, it would seem as if the secondary ones had originated by a process of infection from the first. When there is a perineal wound it is not uncommon for the mass to protrude and fungate, as if it had spread along the granulation tissue; but this may admit of other explanations.

At first the mucous membrane is smooth and unaltered, merely raised and vascular; but ulceration very soon sets in, and the tumor being, as it were, macerated in the urine, the surface soon becomes exceedingly irregular and covered over with sloughing shreds of tissue. The growth itself is never encapsuled or freely movable on the deeper strata; it infiltrates the submucous and muscular coats with great rapidity, and spreads from them to the surrounding organs.

Sometimes the converse is the case, and the bladder becomes secondarily involved from malignant disease of the uterus or rectum.

**General Symptoms of Tumors of the Bladder.**—Hemorrhage and irritability of the bladder, usually amounting to cystitis, are the most prominent.

The former varies in amount and frequency according to the nature of the growth. In papillomata it is profuse, pouring out from the delicate villi, and very irregular in occurrence. Often the first thing noticed is a sudden gush of bright blood following micturition, and then there may be an interval of months. In carcinoma, on the other hand, hemorrhage is usually preceded by increased frequency of micturition and dysuria, and the amount of blood, though small, is much more constant. In the later stages the difference becomes still more marked; with papillomata there is discomfort, sometimes pain; severe cystitis may occur as a complication; the urine may even become ammoniacal and the tumor crusted over with a layer of phosphates; but this is as nothing compared with the severity of the suffering in carcinoma, especially when ulceration sets in. Decomposition of the urine nearly always occurs; the pain is excruciating, radiat-

FIG. 458.—Epithelioma of the Bladder. Two apparently distinct masses opposite to each other.

ing all over the body; the desire to pass water is unceasing, and gives no relief; there is constant burning at the neck of the bladder, rest or sleep is impossible, and the strength rapidly gives way. All these symptoms are intensely aggravated when the growth is near the orifice of the ureters, so that renal troubles are present in addition.

The **diagnosis** must be made from: (*a*) the age of the patient (papillomata and polypi may occur at any time of life, though they are more common in the young—carcinoma probably never before forty); (*b*) the character and order of the symptoms; (*c*) examination of the urine; and (*d*) exploration of the bladder.

Besides the blood that is present in the urine and the increased amount of mucus caused by the cystitis, portions of these growths may occasionally be found and their nature identified under the microscope. Villi are unmistakable; cancer-cells when isolated cannot be distinguished from the normal epithelium of the bladder, but occasionally there are cell-nests or small, sloughing fragments of the growth. It is convenient for this purpose to allow the urine to settle for some hours in a tall, conical glass which can be tapped from the bottom without the introduction of a pipette. In suspected cases, when this fails, an attempt may be

made to obtain some of the fragments by washing out the bladder with a large-eyed catheter, the edges of the opening being rather sharp. If the urine is allowed to discharge itself suddenly, projecting portions of the growth can sometimes be entangled and brought away. Sir H. Thompson on one occasion extracted a fragment with a small lithotrite.

Exact information, particularly as to site, can only be obtained by examination of the bladder itself. The sound is of very little use until the disease is very far advanced; a soft, papillomatous growth cannot be detected by the touch, and though profuse hæmaturia following a carefully conducted examination is very suggestive, it is nothing more unless a fragment of the growth is found. It is probably in this that the cystoscope will show its value most (Fig. 459). It consists of a hollow shaft, of as large a calibre as the urethra will take, with a short beak set on the end at an angle. At the end of the beak is a miniature incandescent electric lamp; in one form of the instrument this is unprotected, in another it is covered in by a cap of metal with a rock-crystal window. At the junction of the beak and the shaft is a second window, closed by a prism, so that the rays of light entering it are reflected down the tube toward the eye of the observer. In the tube are lenses for the purpose of magnifying the image.

For the anterior surface of the bladder (when the beak is turned up) the two

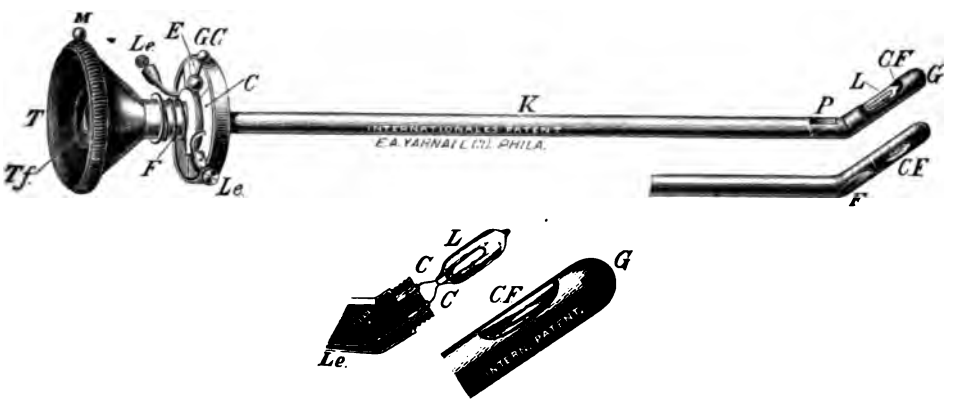



FIG. 459.—Leiter's Cystoscope (Schall's Catalogue), showing two ends, lamp, and cap.

windows are on the concavity; for the trigone and base, on the convexity of the curve. The current is turned on and off as required by means of a small key in the circular handle.

Burnt in air the cap of the instrument becomes exceedingly hot, in water (and urine) it remains perfectly cool, and so long as it is prevented touching the mucous membrane it causes no inconvenience. For this reason the bladder is partly filled with clear water, and the current is not turned on until the instrument is in position. For women a larger tube may be employed.

There is no doubt as to the value of this instrument in distinguishing the site from which a tumor grows; but it must be recollected that it only allows a very minute portion of the bladder wall to be seen at one time, and that even with the naked eye, when the bladder is laid open, it is not always possible to be certain as to the clinical features of a minute growth. Natural rugosities of the bladder wall, low villous growths of an inflammatory character, such as are not unfrequently met with in cases of calculi, prolapse of the ureter (Fig. 470), and many other conditions, present a closely similar appearance.

Examination *per rectum* or *per vaginam* rarely reveals much. Sometimes, in the case of carcinoma, a certain amount of induration may be detected; the tissues seem matted together when pressure is made upon them; but for this to occur the

growth must be so far advanced as to preclude all hope of removal. In women the interior of the bladder may be explored with the finger under an anæsthetic.

**Treatment.**—This must be guided by the nature of the growth. Simple tumors should be removed as soon as possible; if left, the patient becomes exhausted by hemorrhage and cystitis. If the growth is pedunculated and accessible, the operation is one of comparative ease; when these conditions are reversed it may be excessively difficult, and in some instances it has been impossible. In malignant disease it is questionable whether it should be attempted. The cystoscope may reveal the existence of an epithelial growth long before it could be detected in other ways; but even then the hope is very slight, although portions of the bladder wall have been removed on several occasions, with recovery from the effects of the operation, for a time at least.

In men the bladder may be entered either above the pubes or through the perineum. The latter is the simpler, and affords much better drainage, so that there is less risk of septic decomposition and absorption. In young subjects, too, the whole of the interior can be brought within reach of the finger by pressure over the pubes. If, however, the prostate is enlarged, or the pelvis contracted, or if the perineum is thick and rigid, this is scarcely practicable; and pressure on the abdomen has the grave disadvantage of inverting the bladder, so that, before now, portions of the wall have been excised by mistake, and the peritoneal cavity opened. On the other hand, with a suprapubic opening, the whole of the interior can be easily reached with the finger; and, what is very important (for the cystoscope is of no use in an operation, owing to hemorrhage), a great deal of it can be seen.

### *Suprapubic Cystotomy.*

The preliminary steps are the same as in suprapubic lithotomy. The bladder is carefully washed out with an antiseptic; the rectum distended with a rubber bag connected with a receiver; and a second receiver attached to the catheter in the bladder. The incision is the same; the sheath of the recti opened in the same way; and the same precautions taken in dealing with the loose cellular tissue and the large veins in the pre-vesical space. As soon as they come into view, the receiver connected with the bladder is slowly raised, so that it can unfold itself and roll the fold of peritoneum up out of the way.

A hook, or two sutures, should be inserted into the wall of the bladder to prevent its collapsing when the opening is made. This is best done with a sharp bistoury, the incision being of sufficient size to admit the forefinger without stretching.

Various methods may be employed for the removal of the growth, according to its nature, situation, and the extent of its attachment. Small vascular excrescences covering a large portion of the wall, and bleeding at the slightest touch, should be scraped off with the finger nail, or, as Bryant has suggested, with a dry and rather rough sponge. Polypi with a distinct pedicle may either be removed in the same way or twisted off with two pairs of forceps, care being taken that the neck only is grasped, and that only torsion, not traction, is used; or with a snare. The galvano-cautery has been employed, but it does not present any material advantage. Soft, papillomatous growths may be treated in the same fashion, but Thompson's bladder forceps, in which the crushing edge is protected by a free margin projecting beyond, so that when the neck of the growth is caught the wall of the bladder is pushed away, are more safe. In one or two instances catgut ligatures have been placed round the base, and the growth removed with scissors. Whatever method is employed, the whole tumor should be excised as far as it possibly can be: any portion that is left behind is liable to bleed, and, from the bruising it has undergone, to slough and become septic. Hemorrhage must be stopped, and all the blood cleared away by washing out the bladder with water of the temperature of 120° F., and touching any points that keep on oozing with some styptic.

[The sharp spoon or curette may be used with advantage in removal of bladder tumors with broad bases.]

The treatment of the bladder depends upon the condition of the urine and the state of its walls. In young subjects, in whom the urine is healthy and the tissues not bruised, the opening, which contracts at once, should be secured by passing sutures, after Lembert's plan, through the muscular coat only, or by using a double series, as in rupture of the bladder, in the hope of obtaining union by the first intention; and the external wound should be treated in the same way, a large drainage tube being placed in the lower angle behind the pubes. If, however, the urine is septic, or the walls of the bladder thickened from chronic inflammation, or if they are much bruised in the course of the operation, the wound is better left open, with a drainage tube as described in suprapubic lithotomy. A few sutures may be placed in the superficial wound, if it is large, but only at its upper end. If the bladder is accurately sutured, it may not be necessary to pass a catheter at all; but in many cases the urine requires to be drawn off with a soft instrument three or four times a day. With cocaine, the

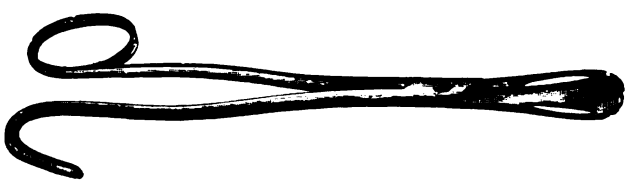


FIG. 460.—Thompson's Bladder Forceps.

process is almost painless. If septic decomposition is feared, especially if the urine was alkaline before the operation, or if a portion of the growth was left behind, or if the bleeding could not be completely stayed, the urethra should be opened in the perineum, and the bladder drained thoroughly. The increased risk is very slight in comparison with the comfort and security against septic absorption that it ensures.

### *Perineal Cystotomy.*

Even when the conditions already mentioned are favorable, this is only suitable for tumors in the immediate neighborhood of the trigone, and for soft, distinctly pedunculated growths springing from other parts. The incisions are the same as for exploring or draining the bladder. Everything must be done by the sense of touch; the exact position and direction of the neck must be made out with the finger, and then either the loop of a snare passed over it, or a pair of forceps introduced to seize it. The great merit of this operation consists in the perfect drainage that it affords afterward, but it is only suitable for growths that can be scraped away at once with the finger nail, or those that are so placed that they can be pinched or twisted off with forceps, without the wall of the bladder running any risk.

In women, tumors of the bladder may be removed either *supra pubes* or through the urethra. The steps of the former operation are the same as those described already; the pressure of the rectal bag upon the urethra is generally sufficient to close it, so that a sufficient quantity of fluid can be injected. In the latter it is not advisable to rely merely upon dilatation; incontinence of urine, partial more often than complete, has been known to follow exploration of the bladder with the finger only; and the repeated introduction of instruments, and their manipulation when tightly grasped, would almost certainly end in this. It is much better to divide the outer two-thirds of the urethra in the middle line with a pair of scissors and stretch the internal orifice. After the operation is finished,

# CHAPTER XXII.

## *DISEASES OF THE PROSTATE.*

### Atrophy of the Prostate.

This has been described both in old age and in young adults; probably it is rather defective development at puberty. It does not give rise to any symptoms.

### Hypertrophy of the Prostate.

The prostate is liable to a peculiar form of enlargement which produces very serious effects upon the other urinary organs. It is rarely met with in men under fifty-five, for there are no symptoms until the size is very considerable; but it begins long before that, and I have known it well marked as early as forty-two. Some enlargement is present in about one-third of those who reach middle life, but it is only in a small proportion of these that there is any interference with the working of the bladder.

**Pathology.**—The nature of the growth is not always the same. In some cases it is a true hypertrophy, all the tissues of the gland enlarging equally, and the normal shape is retained; but this is the exception. The fibrous and muscular elements generally form by far the larger portion; the acini may dilate and become cystic, but there is rarely much adenoid growth. Not unfrequently tumors, resembling the fibro-myomata of the uterus, are found in the interior; they are round and hard, formed of concentric layers, lighter in color than the tissues near them, and surrounded by a kind of capsule, so that they can often be shelled out. As a rule, they consist mainly of fibrous tissue, with some unstriped muscular fibre: occasionally acini and ducts are present as well, and in a few instances they deserve the name of adenoma. They may be single, but more often multiple; in some cases they are as large as a walnut, in others so small that they can scarcely be seen, and they may be buried in the substance of the gland, or project on the exterior as distinct nodules. The size the prostate may attain under these conditions is enormous, and the shape most irregular. Sometimes the lateral lobes are enlarged equally, or one is in great excess over the other; sometimes the median grows out and projects under the mucous membrane of the bladder, until it hangs over the orifice like a valve; in other cases again the enlargement is toward the rectum. The effect on the prostatic urethra is equally variable; it may be merely stretched until it is four inches in length, or it may be so tortuous and displaced that an instrument can hardly pass through it. In a few very rare cases it has been held open in such a way as to cause true incontinence, the urine flowing away from the bladder as it entered, leaving it always empty; much more often the walls are firmly pressed together, so that on transverse section it takes the form of a narrow vertical slit lying between the dense and solid lateral lobes.

*Changes in the Bladder.*—1. *The Neck.*—Owing to the apex of the prostate being fixed by the triangular ligament, the orifice of the bladder, which normally is the lowest point when the body is erect, becomes displaced. If the elongation is uniform it is simply raised, so that the bladder drops as it were into a pouch in front and behind (Fig. 464). More frequently, owing to the greater amount of the growth behind, it is not only raised, but tilted forward so that it faces toward the pubes (Fig. 465), and instead of the mucous surface shelving smoothly down to the urethra, the margins of the orifice are raised up into irregular lips and bosses. The anterior pouch is never very large, unless a calculus is impacted in it; the posterior, on the other hand, owing to the comparative thinness of the muscular coat above the inter-uretral bar, and the yielding nature of the tissues outside,

may be expanded by the forcing of the urine down into it until it projects behind the prostate, between it and the rectum, and sometimes even reaches the perineum.

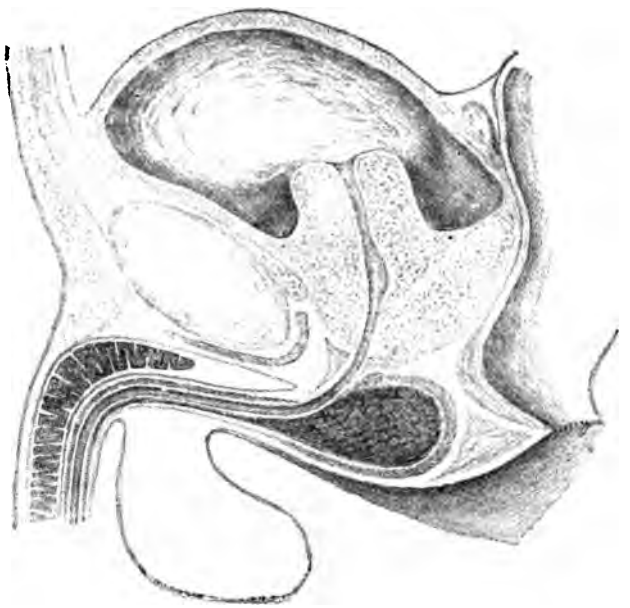


FIG. 464.—Enlargement of the Whole Prostate, with the Formation of Ante- and Post-prostatic Pouches.

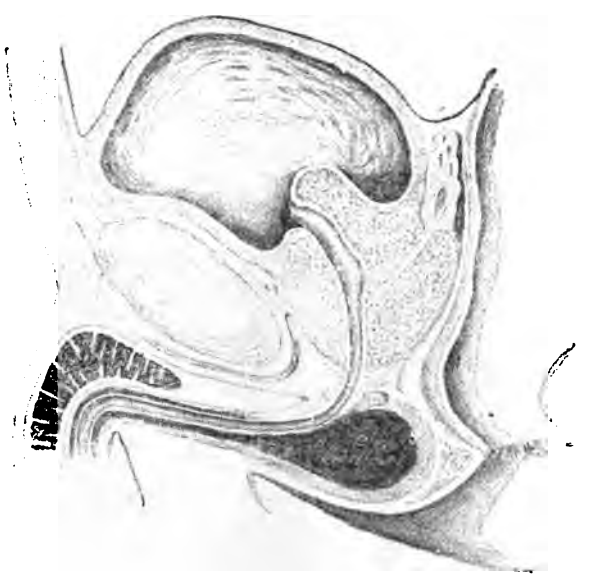


FIG. 465.—Enlargement of Median Lobe of Prostate, showing its Valve-like Action.

2. *The Fundus.*—The alteration in the shape of the neck soon produces changes in the rest. For mechanical reasons, the difficulty of emptying the bladder becomes greater. It may be the third lobe hanging over the orifice like a valve, or the increased length of the neck, forcing the bladder to act at a disadvantage,

and increasing the resistance. If the obstruction is suddenly developed the muscular coat becomes stretched until it can no longer contract, and the bladder distended until it may reach as high as the umbilicus. If, on the other hand, it is slow and gradual, and if the neck of the bladder becomes irritable, so that the calls to micturition are more frequent than natural, the opposite effect is produced: the muscular coat, under the combined effect of increased work and increased frequency, becomes hypertrophied; the capacity diminishes, the walls grow thick and hard, and the bladder can neither collapse nor expand as it ought.

So long as the whole bladder is equally affected and there is no inflammation, the effect is similar to that produced by any other obstructing cause; the uterus and the pelvis of the kidney become dilated, the renal substance is absorbed, the interstitial connective tissue increases, the muscular coat of the bladder becomes fasciculated; and, in advanced cases, hernial protrusions of the mucous membrane make their way between the bands and enlarge into sacculi.

The effect, however, is very seldom uniform. Partly owing to the natural weakness of the posterior wall, partly to the direction of the pressure when the bladder contracts, the urine is driven down into the space behind the prostate, the tissues stretch more and more, and the post-prostatic pouch grows until it becomes a receptacle for urine, which is known as "residual," because it cannot be expelled by the bladder.

Unhappily, this is not all. If inflammation appears all the symptoms are intensely aggravated, the bladder becomes irritable, micturition is more frequent, the lining membrane is swollen and congested and pours out an abundance of mucus which collects behind the prostate; the walls grow thicker, and the irritation spreads up the ureters, so that catarrhal pyelitis and interstitial nephritis soon follow.

If, in such a condition as this, decomposition of urea takes place, and the urine becomes ammoniacal, the effect is infinitely more severe. The patient is already broken down by suffering and want of rest; the tissues are badly nourished; the bladder is fasciculated, perhaps sacculated; the mucous membrane is in a state of chronic inflammation; the pelvis of the kidney is enlarged; its secreting power is diminished; a certain amount of urine, loaded with mucus, is constantly retained in the post-prostatic pouch, and though some of this may be changed when the bladder becomes full, the urine in the sacculi (if there is any) is not; if, in such a condition as this, decomposition of urea once sets in, every drop of urine as it falls from the ureters becomes changed at once, and the bladder in its already diseased state is filled with a most intense irritant which it cannot expel. The result is not difficult to imagine; phosphatic concretions form in all the depressions; the walls are covered with decomposing mucus mixed with salts of lime; the surface is eaten out by ulceration; the pus spreads in the submucous tissue, extending between the fasciculi of the muscular coat; the membrane that lines the ureters and pelvis of the kidneys is almost destroyed, and all the renal substance that the absorption and interstitial nephritis have left is riddled with abscesses.

**Etiology.**—The cause of the hypertrophy is unknown, though it may be compared with the formation of fibroid tumors in the uterus. The muscular system of the prostate is a continuation of that of the bladder, but the gland itself is connected with the sexual rather than the urinary organs. It scarcely exists in infancy and does not attain any size until puberty; in adult life its muscular coat forms, as it were, a funnel-shaped prolongation of the neck of the bladder; a line of separation can be seen on section, but there is nothing on the mucous surface to point to it. For some reason, possibly connected with the condition of the sexual organs, it begins to enlarge as they begin to wane, and the larger and more complex it becomes the more it acquires the appearance of a distinct and independent structure.

Harrison considers the prostate essentially muscle, and holds that the presence of residual urine precedes, and is indirectly the cause of, the hypertrophy. For various reasons, in old age the floor of the bladder has a tendency to sink, so that

there is difficulty in emptying it; the continued effort causes the prostate and the muscular band that passes between the ureters to increase until they coalesce and form a sufficiently powerful floor. The irregularities of growth, and the hypertrophy of the non-muscular tissues, are secondary to this. The effect, if this is the case, is most unfortunate, for the hypertrophy, which is intended to procure the expulsion of the residual urine, makes matters tenfold worse by the changes it induces in the shape of the neck.

With more probability it has been argued that the enlargement is the result of persistent congestion. It is well known that old men with enlarged prostates are subject to the most extraordinary libidinous desires, and it is usual to assign this as the cause. That they are connected is almost certain, but it is not impossible that the cause has been mistaken for the effect, and that the latent erotic desires are manifested because at that time of life the control that was formerly exercised over them has become feeble. Chronic congestion is certainly present in enlargement of the prostate in a degree that would not be suspected from post-mortem examination; and though this disease is met with in all classes, it is of some significance that it occurs most frequently in those who are of full or gouty habit, especially if they are compelled to lead sedentary lives.

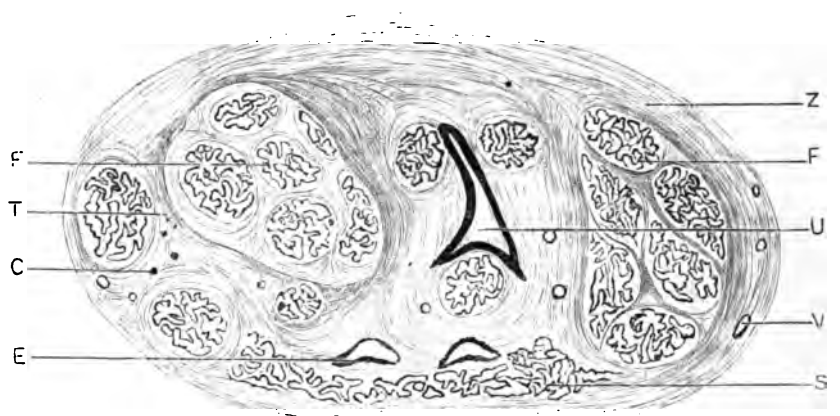



FIG. 466.—Section of Hypertrophied Prostate. (*From Duplay and Reclus.*)

U. Urethra. E. Ejaculatory ducts. T. Fibrous trabeculæ. C. Prostatic nodules. Z. Fibro-muscular capsule. V. Periprostatic veins. F. Fibro-glandular tissue. S. Section of seminal vesicles.

The relation between atony of the bladder and enlargement of the prostate is another question. Harrison regards the former as the origin of the latter; the primary cause is the inability of the bladder to empty itself. Others consider that the two occur together as a result of senile degeneration; while others believe the atony to be entirely the consequence of the obstruction, compensative hypertrophy failing from age. Whatever the primary cause may be, there is no doubt, so far as the later stages are concerned, the last-mentioned view is the correct one.

**Symptoms.**—The symptoms directly due to the enlargement are so indefinite and gradual that in most cases the disease is already advanced before the patient thinks of applying for relief. Exceptionally, retention occurs at an early period.

Frequency of micturition is one of the first symptoms; different positions of the body, various kinds of movement, especially rising from the recumbent position, excite a desire to micturate at once, and the call must be obeyed. In the daytime it may not be severe, or perhaps is not much noticed; but, especially if much fluid is taken late in the evening, the patient has to get out of bed several times toward morning, or while dressing finds that he is constantly desiring to pass

water. In other words, the muscular coat is beginning to fail, and though it may still be capable of emptying a bladder thoroughly when not too full, it cannot deal effectually with an accumulation; a certain amount only is expelled before it is tired out, then it must rest for a time; and the difficulty becomes greater every day, until at length a small but constantly increasing amount is left permanently as residual urine.

For the same reason the stream fails in strength; it is slow in coming and has no force—the urine flows away rather than is driven out: there is hesitation at the commencement, and the last few drops fall without control.

Slight hemorrhage is not unfrequent, especially when the call is urgent; occasionally it is rather profuse; obscure aches and pains are often felt in the loins or down the thighs; erections of the penis and sexual irritation may occur and be very annoying. The rectum becomes affected by the constant straining; prolapse or hemorrhoids may follow; there is a teasing sense of fullness about the anus, and in advanced cases defecation is very liable to take place simultaneously with micturition.

Retention may occur at any time. It may be complete, no drop escaping from the urethra: either the median lobe suddenly blocks the orifice like a valve, or the congestion becomes so great that the obstruction is too much for the weakened muscle. More often it is gradual; the residual urine increases, the strength of the bladder diminishes, and at length it becomes so full that it can contain no more—the urine flows out from it drop by drop as it enters from the ureters. This is *overflow*, and must be clearly distinguished from incontinence, in which the bladder is empty.

The other symptoms depend not so much upon the enlargement as upon its complications—cystitis and pyelonephritis. Even when the inflammation is slight the irritability of the bladder is most distressing; micturition is no sooner ended than the burning begins again; rest at night is impossible; the pain never ceases; the appetite is lost; the bowels are disordered; the health is broken down completely by the ceaseless suffering, and the patient becomes worn out and emaciated. But when the urine becomes ammoniacal and suppurative pyelonephritis is added to the rest, the results are infinitely more severe. The urine is offensive, it is loaded with albumin and throws down a gelatinous deposit of pus mixed with blood and phosphates, the specific gravity is lowered, the quantity fails. There is partial suppression, and partly from this, partly from the constant suffering and the septic absorption from the ulcerated mucous membrane of the bladder, the constitution becomes utterly broken down. The temperature may not rise, sometimes it is even subnormal, but the tongue becomes dry and brown; the pulse small and quick; low muttering delirium sets in; the restlessness is extreme, the patient wants incessantly to get out of bed; the strength fails completely, and exhaustion or uræmia and coma speedily follow.

**Diagnosis.**—Enlargement of the prostate can only be proved by an examination of the urethra or rectum, or the two together. If the rectum only is examined, the patient may either stand with the feet slightly separated and stoop forward over the end of a sofa, or, more comfortably, lie on his side close to the edge of a firm couch with the knees drawn well up. The central portion of a healthy prostate is soft and yielding, the sides are more firm, but shade off gradually into the tissues around; when it is enlarged it feels dense and resistant, or the consistence is uneven, and the outline more sharply marked and irregular. In extreme cases a shapeless mass projects into the rectum, extending far beyond the reach of the finger, both above and on either side.

The degree of obstruction can only be ascertained by passing a catheter; if the growth extends toward the rectum, the power of the bladder may not be much impaired; on the other hand, a very slight enlargement of the middle lobe may cause complete retention. A sound may be used, but as instruments are always an evil, it is better to take a catheter, and to direct the patient to empty the bladder first, so that not only the shape of the gland but the amount of the residual urine

may be ascertained. The length of the enlargement may be judged by the dista the catheter passes before entering the bladder; the height to which the mic lobe rises by the depth to which the handle of the instrument must be depre between the patient's legs. The most accurate information is obtained by c joined rectal and urethral examination; the distance between the catheter and finger can be estimated, and the presence of irregular nodules or uneven enla ment of one lobe better made out.

Enlargement due to inflammation is distinguished by the pain and the ser tion of heat in the rectum, but it must not be forgotten that a certain amount chronic inflammation is not uncommon in enlargement of the prostate, even w instruments have not been used. How far the increase is due to passive congest is much more difficult; but if the mucous membrane bleeds very readily whe large instrument is passed, and the hemorrhoidal veins are much enlarged, i probable that some at least is caused by this. In malignant disease of the pros the growth is more rapid and the pain more intense, radiating from the perine down the thighs. Generally the prostate is softer; and profuse hæmaturia, tow the end of micturition, is the rule.

It is not sufficient, however, to make out that the prostate is enlarged, or e that the median lobe has grown out and obstructs the flow; the condition of bladder must be ascertained as well, how far it is already in a state of atony, a what amount of residual urine is left. This can only be done by passing a cathet but as this is a proceeding which is sometimes followed by very serious consequenc especially when done for the first time, or when there is residual urine, certain p cautions should always be adopted. The patient should be directed to lie do and keep warm and quiet for the rest of the day; it is best for him to remain bed, but at any rate he should not go out or expose himself to cold. Before catheter is passed the bladder should be emptied as thoroughly as possible; object is to find out the quantity that cannot be expelled; not unfrequently must be done on more than one occasion before the amount can be definitely fix as from nervousness or other causes it often happens that the bladder does not so well as usual. The best instrument is a soft rubber catheter of moderate si or, if this will not find its way in, a black one with the point well bent up (cou or a gum-elastic fitted with a stylet, so that if its progress is stopped abruptly end may be tilted up. If a large amount of residual urine has been drawn off (m than five or six ounces) a smaller quantity of a warm antiseptic solution should introduced and left; the bladder cannot readily accustom itself to such alte conditions, and must be gradually educated, the quantity being reduced e second or third day. In all such cases the patient should be cautioned that t is almost certain to be some slight fever after the operation, and that re bed until the temperature is normal and the bladder has grown accustomed t new condition is absolutely essential.

**Treatment.**—1. *Palliative.*—(*a*) *General.*—The treatment of enlarge of the prostate depends upon the condition of the bladder. If the patient is not seriously disturbed at night, and if there is only a small amount of re urine, every effort must be made to maintain the strength of the muscular coat prevent it being strained. The bowels must be opened regularly; motions formed at stated times; a regular amount of fluid taken, anything acting especially being avoided; and wines and spirits commenced very sparingly clothing should be warm, so that there is no sudden chill or congestion organs; and, especially if there is any tendency to gout, the diet should and without much meat, so that the urine may be as little irritating as possible

(*b*) *Catheters.*—If, however, as generally happens, the atony of the coat is already advanced, and if two or three ounces of urine remain in the bladder on more than one occasion, showing that it is impossible to be taken to remove it thoroughly, at least once in the twenty-four hours true that the passage of a catheter, under these conditions, is fraught with fever, even when every precaution is adopted; and although it may

through the substance of the prostate until the bladder is tapped; then the trocar is withdrawn, a self-retaining catheter introduced in its place, and the cannula removed. As soon as the urine begins to improve, the patient is allowed to get up and move about; and, if it is thought desirable, the apparatus may be permanently retained, the catheter being connected by means of a rubber tube with a urinal strapped on to the leg. The amount of leakage by the side is very slight. In most cases, after a few weeks the urine begins to come through the urethra again; and this may be taken as a signal that the drain is no longer needed. Harrison has noted the curious fact that in several of these cases the prostate has shrunk to such an extent after the operation that the enlargement can hardly be detected through the rectum, and the patient experiences little or no difficulty with his urine afterward.

In extreme cases, in which, owing to the enormous size of the prostate or to other special complications, a permanent opening affords a better chance of relief, suprapubic puncture may be performed; or the bladder may be deliberately opened in the same region and cleared of all adhering mucus and phosphates, a properly arranged tube and urinal being worn afterward, as in cases of impermeable stricture.

Other complications that occur in the course of enlargement of the prostate may require special treatment. Retention of urine must be relieved by catheter as

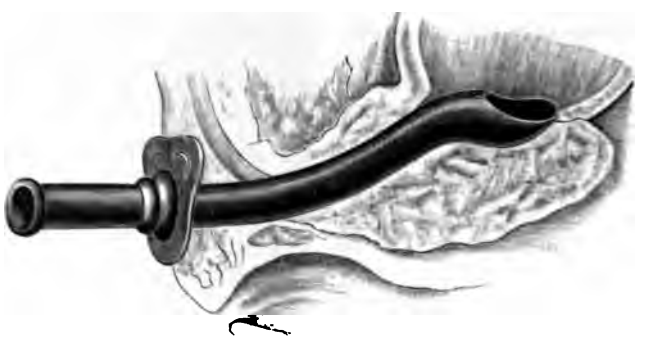


FIG. 467.—Watson's Cannula in Position.

soon as possible. The muscular coat is already in a state of partial atony, and a slight degree of over-distention is sufficient to increase it until the power of contraction is permanently lost. If the catheter cannot be passed, hot baths and similar remedies are useless; an opening must be made in the bladder at once, but the necessity for this is very rare.

Hemorrhage is seldom serious; sometimes it appears to give relief, especially the slight amount which in some patients is so constant as almost to deserve to be called periodic. When it follows the use of a catheter it may either be due to rupture of the engorged veins, or to the effect of suddenly relieving the pressure upon the wall of the bladder. In either case the blood and the urine are intimately mixed, and though the color may be bright red just at first, it soon becomes smoky and brown. The patient should be kept quiet in bed, and the urine drawn off as occasion requires with a soft catheter; special treatment is seldom needed. If it persists, the bladder may be washed out with an iced infusion of matico or tincture of hamamelis, and opium with garlic and sulphuric acids given internally. Clots, as a rule, disintegrate of themselves, but they may require an evacuator.

If there is extreme pain at the neck of the bladder when the catheter touches a certain spot, and ulceration or fissure can be diagnosed by the endoscope, a solution of nitrate of silver (gr. v ad ℥j) may be brushed over it with a properly

arranged injector. Sacculi in the walls should be drained and washed out like the rest of the bladder, but the openings are so small that it is seldom possible to find them without the aid of a cystoscope. The ordinary method of washing out the bladder merely tends to make them larger, as it fills them under pressure with fluid which they cannot expel again. On the other hand, there are several cases on record in which regular drainage has led, if not to their disappearance, at least to their causing no further trouble. They may sometimes be suspected from the peculiar character of the urine, or from the way in which a catheter, after passing the normal distance and drawing off one kind of urine, suddenly slips in further and draws off something different.

Phosphatic calculi are not at all uncommon, but fortunately they are so soft that they can be crushed and washed out without prolonged instrumentation. It is always advisable, however, not to allow them to attain too large a size. Recurrence is very common, as the same conditions persist.

2. *Operative Treatment.*—In performing lateral lithotomy portions of the prostate have often been removed without ill consequence of any kind. Some of these were pedunculated masses projecting into the urethra or the bladder, so that they were caught (occasionally by accident) in the blades of the forceps; others were growths in the substance of the gland itself, which shelled out from the pressure of the finger as soon as the tissues around them were incised. Moreover, the gland has been repeatedly punctured from the perineum, and by means of catheters through the urethra. Occasionally there has been hemorrhage, and suppuration and sloughing have been known to follow, though rarely; as a rule, the wound heals without difficulty, sometimes relieving the condition of the bladder by making a direct channel to the pouch behind. In a few instances it has been noticed that after these partial operations the prostate has undergone a kind of subinvolution, and diminishes to an extent that cannot be accounted for even when allowance is made for the cessation of the congestion and for cicatrization. Whether in this there is a further analogy to the fibromyomata of the uterus remains to be proved. Unfortunately, it does not happen with sufficient frequency to enable any reliance to be placed upon it.

In some of the cases in which the residual urine has been drained in this way, even when the amount was large, the bladder has recovered its tone, the irritability has subsided, and catheters have been dispensed with. The question, therefore, arises whether it is not possible, without running too much risk, to produce the same result at an earlier period, before the bladder and the kidneys are irretrievably ruined.

There are three ways in which the prostate may be approached: through the urethra, through the perineum, and, after suprapubic cystotomy, through the bladder.

(*a*) *Urethral Operations.*—Of these the best known are Mercier's and Bottini's. In the former an instrument shaped like a short-beaked lithotrite, with tolerably sharp edges, is used to punch out portions of the floor. In the latter a fresh urethra is bored through the substance of the gland by means of the galvanocautery.

This has been done on several occasions (once on a medical man without an anæsthetic) with very distinct benefit. In the first case the residual urine amounted to thirteen ounces, and the dysuria was so great that a catheter had to be passed every two hours, night and day; the operation only lasted forty-five seconds; there was no fever afterward, and the bladder regained a great deal of its power. In others, however, there has been severe vesical tenesmus after the operation, and sloughs have continued to come away through the urethra for upward of three weeks.

(*b*) *Perineal Operation.*—In this an incision is made in the middle line, in front of the anus, and the membranous portion of the urethra opened as in the operation for draining the bladder. The finger is then passed into the prostatic portion and the obstruction dealt with according to its shape and position. A

median outgrowth, if sufficiently pedunculated, may be excised or removed by means of a snare; if it is sessile it may be punched out with a modification of Mercier's prostatome, or incised with a straight probe-pointed knife, and then torn with the finger until the passage into the pouch is straight. Sometimes it answers better to pass a curved bistoury through the substance of the gland into the post-prostatic pouch, and cut into the urethra so as to ensure that division is complete. Afterward a full-sized drainage tube is introduced and retained until the urine begins to come by the natural route. When it is withdrawn the perineal wound usually closes rapidly. If the section is sufficiently deep a catheter is not required afterward, but it should still be passed occasionally as a precaution.

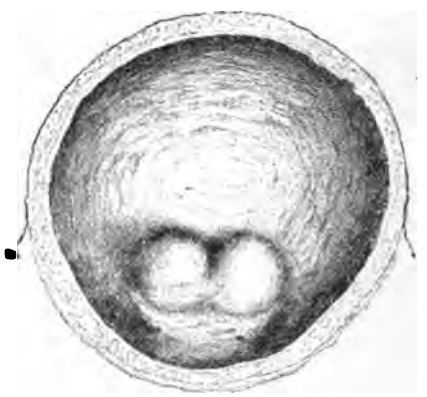


FIG. 468.—Neck of the Bladder seen from within, in a case of Enlarged Prostate. The orifice of the urethra lies in the angle between the two projections.

(*c*) *Suprapubic Operation.*—This was first performed after the removal of calculi, and subsequently as an independent operation. The rectum must be distended, as in suprapubic cystotomy, and the incisions through the abdominal wall and into the bladder made with the usual precautions. The finger is then introduced to ascertain the size and shape of the mass. There are, according to McGill, three chief varieties admitting of surgical relief: in the first there is a uniform circular projection surrounding the internal orifice of the urethra; in the second a sessile enlargement of the median lobe situated partly in the prostatic urethra and partly in the position of the uvula vesicæ; in the third a pedunculated outgrowth. Of these the last can be removed easily with scissors, and the second may be treated in the same way by dividing the mucous membrane over it freely and tearing it with forceps. The scissors should have long handles with short blades, curved in various directions. The collar enlargement is more difficult. McGill divides it longitudinally, first in front and then behind, by inserting one blade of the scissors into the urethra, and cutting in each direction. By this the projecting part is divided into two halves, which can be removed by enucleation with the finger. The whole of the projecting valve must be excised, and after the operation the forefinger must be passed down the urethra, to make certain that it is free. Hemorrhage is checked by a hot antiseptic solution; and the bladder drained with a tube through the lower angle of the wound for forty-eight hours.

It is impossible at the present time to give a definite opinion as to the relative or absolute merits of these operations. The last is the most complete, but at the same time by far the most serious. Mercier's is certainly insufficient, and shares with Bottini's the grave disadvantage of uncertainty. It is scarcely possible, even with the aid of the sound and the cystoscope (when this can be used) to obtain sufficiently definite information concerning the relations of the prostate and the bladder under their altered conditions.

The choice between the suprapubic and perineal operations rests on different grounds. There are three chief factors upon which the selection depends; of these two can be ascertained before anything is done; the third cannot. One is the distance of the bladder from the perineum; if this is more than three inches and a half the finger cannot reach it, and the operation becomes exceedingly difficult. Possibly the urethroscope with a very wide tube, used through the perineal opening, might prove of assistance, but the view would soon be obscured by the bleeding. The second is the condition of the bladder; if it is small, rigid, and degenerate from chronic cystitis, the suprapubic operation is out of the question. The third is the shape of the obtruding mass. In a small proportion of cases this is such as

to preclude effectual removal through a perineal opening, but this can only be ascertained by actual exploration.

The perineal operation is the more simple: it gives much better drainage, and these cases nearly always require it, owing to the presence of cystitis, and perhaps ammoniacal urine. I have performed prostatotomy through it on several occasions with very great benefit; prostatectomy, sufficient to remove the median obstruction and relieve the bladder, is possible in a large proportion of cases; and finally, in the few instances in which prostatectomy cannot be managed in this way, and is possible by the suprapubic method, the perineal opening does not add materially to the gravity of the operation, and is of the greatest assistance for draining the bladder and preventing septic absorption afterward.

### Malignant Disease of the Prostate.

Carcinoma and sarcoma both occur, but the former is the more common. It is usually of the glandular or spheroidal-celled type, and is more often soft than hard. Colloid carcinoma has also been described.

**Symptoms.**—Carcinoma is generally met with after middle life; sarcoma may occur earlier. The symptoms at the first are the same as those of simple enlargement or chronic inflammation, but they soon become more intense and acute. The obstruction to the flow of urine comes on more quickly; the uneasiness and frequency of micturition are more marked, and the pain is more severe, radiating from the perineum down the thigh and to the end of the penis. Later, as the disease advances, it may become agonizing. Hemorrhages are common, often profuse, occurring with or without micturition, and tending greatly to reduce the patient's strength. Cystitis and decomposition of the urine follow; the glands in the iliac region become involved, and death usually occurs in a comparatively short time from exhaustion, interference with the urinary secretion, want of rest, and pain.

Operative treatment is practically out of the question, though in one or two instances obstructing portions have been removed with a certain amount of benefit. Suprapubic puncture at an early period is more effectual, though this cannot relieve the pain. The bowels must be kept gently relaxed, a soft catheter used when required, the interior of the bladder washed out with weak antiseptics, and the pain controlled, as far as possible, by means of morphia.

### Prostatitis.

Inflammation of the prostate may be either follicular or parenchymatous. In the former, the mucous membrane and the follicles opening upon it are chiefly concerned; abscesses may form, but they are rarely large, and they always burst into the urethra. In the latter, the whole substance of the gland is involved; and, if suppuration occurs, the pus may spread into the tissues around, and point in the perineum, or even in the groin.

#### 1. *Follicular Prostatitis.*

This may be either acute or chronic. The former is usually due to gonorrhœa, but it may be caused by injury (impaction of calculi, the passage of large instruments, or the use of caustics), especially if the gland is already in a state of congestion from excessive sexual excitement, advanced stricture, or other causes. Bicycle riding is said to produce the same effect. It is very doubtful if simple irritation by the urine is sufficient to bring it on, though it may prevent its getting well. The chronic form is either the result of the acute, or commences as such, from similar causes acting with less energy.

(*a*) *Acute.*—This usually occurs during the acute stage of gonorrhœa, but it may be brought on later by the use of injections or the passage of instruments. There is intense burning at the neck of the bladder; the desire to pass water

never ceases; the stream from the first is small; a few drops only are ejected, without the least relief, and even this may be impossible. There is violent throbbing in the perineum; the pain extends down the thighs and into the loins; in the rectum there is a constant sense of fullness and tenesmus, with great suffering as soon as the bowels begin to act; and, if the finger is introduced, the prostate feels swollen and burning hot. The temperature rises from the first; the pulse becomes full and quick; the distress is very great, and not unfrequently there is high fever. Suppuration is usually, but not always, indicated by a chill.

When the inflammation is due to other causes the course is generally less severe; and occasionally large chronic abscesses form in the substance of the gland, without any marked symptoms other than those of irritation about the neck of the bladder and obstruction to the passage of urine.

If the treatment is active and early, the symptoms usually subside. Occasionally the inflammation becomes chronic; the irritability and pain persist, though with less severity; there is a certain amount of discharge washed down by the first few drops of urine; and whenever there is the least indiscretion, all the old trouble threatens to return.

**Treatment.**—The patient should be confined to bed and placed upon milk diet; a hip-bath, as hot as can be borne, should be given twice a day, and the bowels should be freely opened once; after that it is better to leave them alone, owing to the pain and need for local rest. The rectum may be washed out with hot enemata, leeches applied to the perineum, and the bleeding encouraged by fomentations. The pain must be relieved by suppositories or hypodermic injections of morphia. Sometimes the inflammation can be cut short by full doses of vinum antimoniale every hour, until nausea is produced. If retention occurs, the urine must be drawn off with a catheter, either a soft rubber one of medium size or a black one, *coudé*, so that it can ride easily over the obstruction.

If suppuration is suspected, and there is any redness or fullness in the perineum, a free median incision should be made: if pus is not found, the hemorrhage will give relief; but, though this is not uncommon when the suppuration is in connection with the membranous portion of the urethra or Cowper's glands, it rarely occurs in prostatitis. Generally the abscess bursts into the urethra, either of itself or when a catheter is passed: there is a profuse discharge, and at once a sensation of intense relief. Owing to the extreme tension, the cavity contracts immediately, and, so long as the abscess is acute, fistula and extravasation of urine rarely follow.

(*b*) *Chronic Follicular Prostatitis.*—This may be the relic of an acute attack, or it may result directly from gonorrhœa, stricture, or prolonged masturbation.

The symptoms are the same, but of less severity; and the affection is often mistaken for calculus. There is increased frequency of micturition; the stream flows away, especially the last few drops, without any force; almost always there is pain and scalding toward the end, and sometimes a few drops of blood escape at the same time. Shreds of mucus and casts of the prostatic follicles accumulate in the urethra, and are either washed down with the first few drops, or exude from the meatus during defecation. In the latter case, they are often mistaken for the secretion of the testes, and the patients are convinced that they are suffering from spermatorrhœa. Gleet is not present unless the penile portion of the urethra is involved as well.

Examined through the rectum, the gland feels enlarged and tender. There is constant aching in the perineum, extending down the thighs and across the loins, much more severe during defecation and micturition, because then the prostate is compressed. The constant straining usually brings on hemorrhoids as well; the irritation spreads to the bladder, and cystitis follows; at first it may be slight, but by degrees the walls become hypertrophied and lose their flexibility; and then, often it is not properly emptied, even though the patient may pass water every hour. At last the health breaks down altogether, and mental as well as bodily vigor is seriously impaired.

**Treatment.**—This affection is generally of a most obstinate character, and requires prolonged and careful attention. Fresh air and change of scene are often necessary; the food must be good, but not rich; stimulants, especially beer, sherry, and champagne, must be prohibited, and tonics, iron, nux vomica, cod-liver oil, and phosphoric acid, given according to the condition of the patient. The bowels should be kept slightly relaxed, so that there may be no straining at stool, and excessive exercise, especially on horseback, or on a bicycle, and sexual indulgence must be avoided.

In most cases local treatment is essential. Lightly blistering the perineum is sometimes of service; small patches should be painted over with blistering fluid on successive days, taking care to avoid the skin of the scrotum, and, if possible, not raising actual vesicles, or a little dry mustard may be rubbed in. Astringent injections applied to the part itself are of great advantage, using either an injector or a prostatic syringe. Glycerine and tannic acid, or five minims of a two per cent. solution of nitrate of silver, or nitrate of bismuth may be applied without fear; stronger applications (even twenty grains of nitrate of silver to the ounce) are employed by some, but the pain they cause is very severe (though this may be prevented by cocaine), and their use is often followed by vesical tenesmus and a blood-stained discharge. The urethra should be washed out with hot salt and water first, to clear away adherent mucus, and the patient kept in the recumbent position for the rest of the day, as a precaution against epididymitis. If these fail, tannic acid, eucalyptus oil, and other astringents, made into bougies, may succeed, but they must be introduced with a proper instrument, as they are too soft to pass of themselves. They soon become liquid, and the mucous membrane remains for some time bathed with the products of their solution.

### *Parenchymatous Prostatitis.*

Gout, tubercle, and injury are the chief causes. Occasionally it is due to syphilis, and it is said that sometimes inflammation arises from exposure.

*Gouty prostatitis* is not uncommon toward middle life in men who live rather freely, and whose urine is loaded with uric acid. The commencement is tolerably acute, and is often assigned to cold: the fever is not so high as in the acute follicular form; there is very rarely retention of urine, and probably never actual suppuration. The irritability of the bladder is even more intense; the urine is ejected spasmodically, almost without the patient having any control, and the pain is very severe, especially at night. *Per rectum*, the prostate is distinctly enlarged, hardened, and exceedingly tender. Sometimes there is œdema of the prepuce, or partial erection from obstruction of the veins of the penis. Generally the attack subsides readily under colchicum and the alkaline carbonates; the bowels should be freely opened with blue pill, the diet carefully restricted, and a regular amount of fluid (hot water is the best) taken at stated times, to diminish the acidity of the urine and prevent any concentration. Gouty prostatitis may in some cases lead to the accumulation of residual urine; the gland is very sensitive, and, to avoid squeezing it, the patient never thoroughly empties the bladder; after a time a certain amount is constantly retained, the walls become atonied, and the power of complete evacuation is lost.

*Tubercular prostatitis* usually occurs in young adults, in association with tubercular disease of the bladder or kidneys; sometimes it appears to follow an attack of gonorrhœa, but it is rarely as a primary affection. In the earlier stages the symptoms are almost the same as those of calculus; micturition is much too frequent, the patient wanting to pass water every hour; hæmaturia is often present, especially as the neck of the bladder is beginning to contract, and, at the same time, there is a sharp, cutting pain at the end of the penis. *Per rectum*, the prostate is seldom much enlarged; at first it is rather harder than natural, and perhaps nodular, but, as the caseous masses break down and disappear, it may become abnormally soft. In the later stages the urine brings away with it pus

and caseating debris, full of tubercle bacilli, the gland itself is completely excavated, the irritability and pain become unbearable, and the patient grows weaker and weaker. Generally speaking, there are deposits in other organs as well.

The **diagnosis** in the early stages, when there is some hope of removing, or at least arresting the disease, can only be made with the endoscope. If this is not

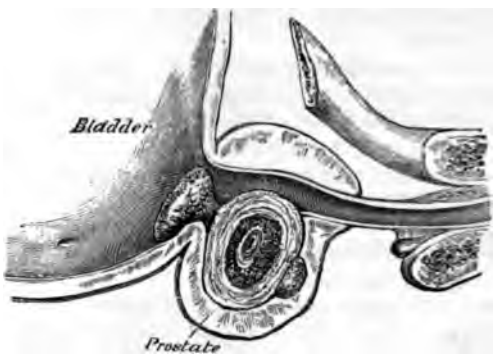



FIG. 469.—Prostato-vesical Calculus.

used, neighboring organs, such as the bladder or vesiculæ seminales, are nearly sure to be involved before there is any definite evidence. Constitutional treatment is of great importance, but it does not seem to have the same influence over tuberculosis of the genito-urinary tract as when it occurs in other parts—the bones, for example. Locally, iodoform, applied in an emulsion or as a pessary, is of some

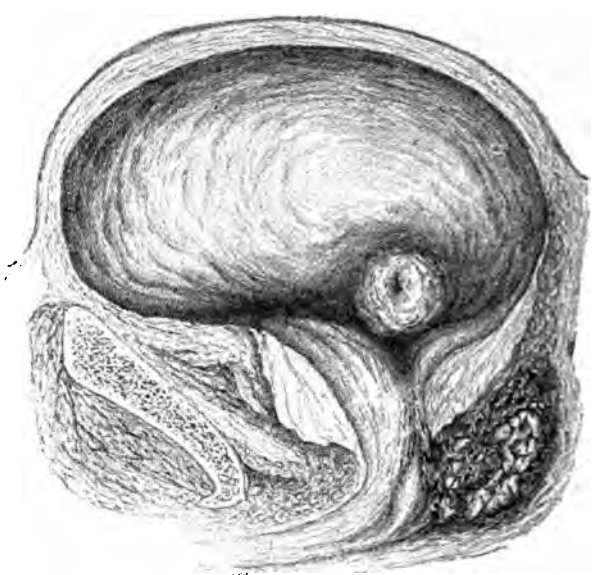


FIG. 470.—Prostatic Calculi with some Enlargement, causing Prolapse of the Ureter. (Section a little to the left of the middle line.)

service; but possibly, if the diagnosis were confirmed by microscopic examination, and it was fairly certain that the other organs were sound, it would be better, if speedy improvement did not take place with ordinary measures, to open the prostatic urethra from the perineum, and try free scraping and the application of lactic acid. In the later stages morphia is the only drug that relieves the pain. If the

disease is limited to the prostate the bladder may be drained through the perineum; but, unfortunately, this often fails to give relief, owing to the other organs being involved as well.

*Suppurative Prostatitis.*—Suppuration in and around the prostate is occasionally the immediate cause of death after lithotrity, operations about the neck of the bladder, or the passage of very large instruments, especially when there is old-standing disease of the kidneys. It may commence in the prostate itself, the gland being destroyed, the capsule giving way and the pus spreading in the loose tissue around the neck of the bladder, until, if the patient live sufficiently long, it points in the iliac fossa; or it may be periprostatic from the first, originating in tissues that have been saturated with septic material by absorption from the bladder. There may or may not be a rigor; as a rule, the symptoms are exceedingly vague, being masked entirely by the vesical and renal trouble, and in the majority of instances the diagnosis is not made until the patient is sinking from septicæmia and suppression of urine.

### Prostatic Calculi.

Calculi occasionally leave the bladder and become impacted in the prostatic portion of the urethra; under these circumstances they may sink into the substance of the gland, and become, as it were, encysted, with a portion of their surface projecting. True prostatic calculi, however, are not uncommon, originating in the follicles, and gradually growing larger and larger until the intervening tissue is absorbed, and they come into contact with each other. They are always multiple, rarely very large, and usually faceted from pressure; as a rule they contain about 85 per cent. of phosphate of lime with a trace of carbonate, and about 15 per cent. of animal matter, but the proportion of the latter is sometimes higher toward the centre. In one or two cases they have coalesced into large masses. So long as they are small they do not give rise to any symptoms; as they grow larger they may cause inflammation and even suppuration. In one case under my care, admitted for extravasation of urine consequent on this, there was, in addition to the prostatic calculi, a much larger one in the bladder, composed of bone earth with a little carbonate of lime.

# CHAPTER XXIII.

## *INJURIES AND DISEASES OF THE URETHRA.*

### Injuries of the Urethra.

The mucous lining of the urethra may be torn by calculi, or perforated with catheters, or bruised from blows upon the perineum, or from attempts at forcibly straightening out chordee; but serious consequences rarely follow. There is a small amount of hemorrhage, perhaps sufficient to drip from the orifice; micturition is attended with scalding, and there is soreness about the part with a slight mucous discharge, but extravasation of urine seldom follows a superficial injury unless there is an obstruction as well.

False passages escape from their direction. They start in most cases from the floor, in front of the bulb, very often on the left side, and run from there between the bladder and the rectum, but the opening lies toward the meatus, so that urine does not enter.

*Rupture of the urethra* may be caused by a kick or violent blow in the perineum, or by fracture of the pelvis.*

In the former case the urethra is torn at the junction of the membranous and bulbous parts, the anterior layer of the triangular ligament giving way as well; sometimes the whole circumference is ruptured, and the ends are widely separated; sometimes there is only a rent on the floor, the roof remaining intact. Hemorrhage is usually profuse, forming a swelling in the perineum and scrotum, and often dripping freely from the meatus, but no urine is extravasated until an attempt is made to relieve the bladder.

In the latter, when the rupture is the result of fracture of the pelvis or separation of the symphysis, the deeper part of the urethra and the neck of the bladder generally suffer; blood does not escape externally until an attempt is made to pass urine; but this, from the moment of the accident, begins to leak out from the bladder and infiltrate the tissues around, setting up the most intense inflammation.

The symptoms depend upon the seat of injury. If the rupture is in front of the triangular ligament, or involves the anterior layer of it, a swelling rapidly forms in the perineum; blood drips slowly from the meatus, and either the patient is unable to pass any urine, or, if he makes the attempt, it pours into the loose cellular tissue of the perineum, causing the most intense burning. If an attempt is made to pass a catheter, either it stops abruptly at the seat of injury, the point rubbing against the lacerated tissues, or it suddenly slips onward, entering the bladder and drawing off clear urine. This accident is nearly always followed by a stricture, the severity of which depends upon the amount of suppuration. If the rupture is complete, and there is the least infiltration of urine, the cicatricial tissue becomes so hard and dense that practically the urethra is closed (unless steps are taken to prevent it); if the mucous membrane is partly intact and there is no suppuration, there may be some obstruction, but the tendency to contraction is not nearly so severe.

On the other hand, when the deeper part of the urethra is torn, external hemorrhage and swelling are rarely present, but the pain and the shock are much more severe, and, owing to the urine soaking at once into the cellular tissue, inflammation and fever soon set in. If a catheter is passed there is no difficulty until it begins to wind under the pubic symphysis; then it either stops altogether,

[* The editor has seen a case of rupture of the membranous portion produced by a fall from the fourth story of a building. The patient had a full bladder at the time of the accident.]

### Calculus in the Urethra.

Calculi are occasionally formed in the urethra in the dilated and fasciculated pouch that develops behind a stricture; but nearly always the nucleus is carried down from the bladder. The symptoms depend upon the degree of obstruction: if the calculus is large enough to block the urethra of itself, or so sharp and angular as to bring about the same result by the spasm that it excites, retention occurs; and if speedy relief is not given, ulceration and extravasation follow. If, on the other hand, it is small and lodged in a diverticulum, it may continue to increase from the deposit of phosphates on its surface and wear its way into the tissues, until at length it forms an enormous mass, lying in the substance of the penis, alongside the urethra, almost buried under the mucous membrane.

*Impacted Calculus.*—This is more common in children than in adults, owing to the greater frequency of stone in them and the small size of their urinary passages; the calculus is washed down from the bladder during the act of micturition and suddenly arrested, generally in the membranous part or at the meatus. The stream stops suddenly, there is a sharp cutting pain at the end of the penis with violent straining, and perhaps a few drops of blood exude from the urethra, especially if the calculus is sharp and angular. For a time the straining continues, the bladder becomes more and more distended, and then either sudden extravasation occurs, or, if a small quantity of urine can escape by the side, so that there is not such immediate tension, inflammation sets in, ending in urinary abscess and fistula.

There is seldom difficulty in the diagnosis. The history of the case, the way in which the child keeps screaming and pulling at the end of its penis, the retention of urine, which is so rare in children from any other cause, and the few drops of blood are distinctive. Very often the calculus can be felt from the outside. If this cannot be done, a small catheter may be passed down the urethra; sometimes it comes to an abrupt stop against the stone, sometimes it slips by the side of it with a rough, grating sensation, and, entering the bladder, gives relief for the moment. If any time has elapsed since the accident, the bladder may be distended up to the pubes; or there may already be a swelling in the perineum due to inflammation and commencing extravasation.

A calculus in the penile part can generally be worked forward with the fingers until it reaches the orifice, when a small incision may be necessary to extract it. If this does not answer, a scoop or a pair of urethral ["alligator"] forceps may be passed down the urethra, and an attempt made to draw it forward; but this may inflict serious injury upon the mucous membrane. If it is fixed or too far back for this, the patient should be placed in the lithotomy position, the skin over the projection stretched with the finger and thumb of the left hand, and a small median incision made down on to it. Generally the calculus springs out at once, and the wound can be left to granulate. The bulb should, if possible, not be incised. If the calculus is near the neck of the bladder it should either be removed by the median operation, or, if there is a suitable instrument handy, pushed further back and crushed with a lithotrite.

Foreign bodies introduced into the urethra may require extraction. Urethral forceps should be avoided as far as possible; sometimes, by placing the patient in a hot bath, giving him plenty of liquid to drink, and directing him to hold his water, sufficient head can be obtained to drive out such an obstruction, for example, as the end of a catheter broken off in a stricture; but this should not be tried too long. Hair-pins, on the other hand, and such like structures, nearly always require incision.

The cases in which the obstruction is slight and the stone lies out of the way are much more rare, and as a rule are only met with in elderly men. In a few instances huge cylindrical calculi have been found, three or four inches in length and one and a half in circumference. These generally lie in the tissues by the side of the urethra, occupying a cavity which they have worn out for themselves,

and sometimes are so invested by the mucous membrane that a sound passed down the urethra slips by them without any of the characteristic grating.

### The Passage of Catheters, and the General Effect of Operations upon the Urethra.

Catheters are made of various materials, some rigid, others flexible in various degrees. Metal ones have a fixed curve, occupying a quarter of a circle of a radius of three and a half inches. (Prostatic ones should be fifteen inches long, and the radius of the curve barely three.) The handle should be bent a little downward, so that if the patient is lying down the urine may not be ejected all over the bed; the other end should be solid, with a smooth eye on the side about a quarter of an inch back. If it is hollow to the end the space beyond the eye is never cleaned.

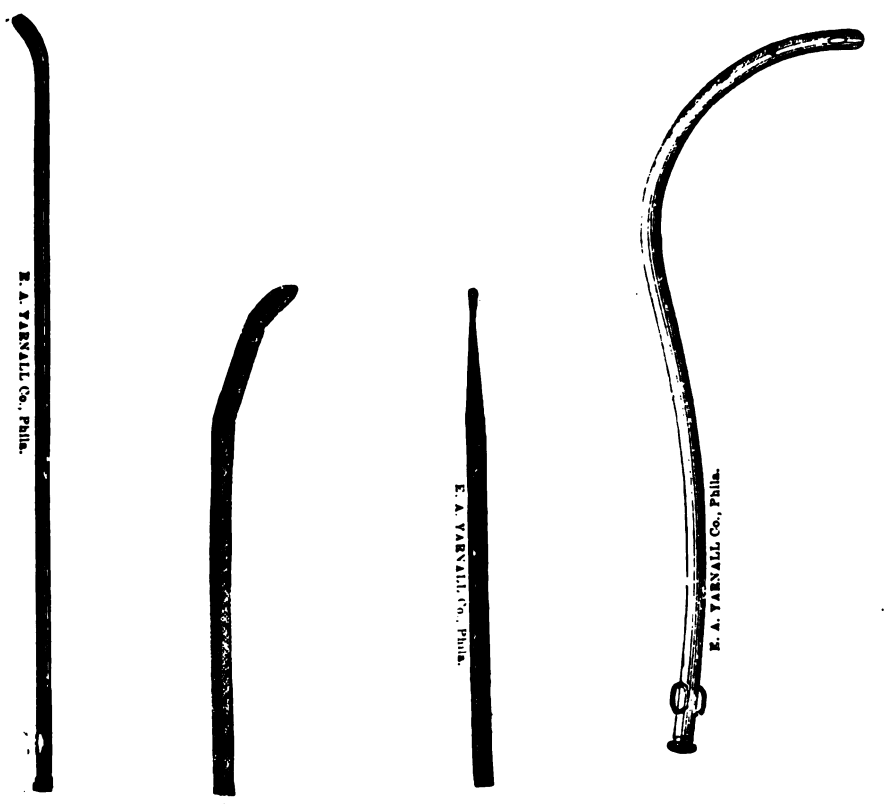



Fig. 471.—Various Forms of Catheters; *a*, coudé; *b*, bi-coudé; *c*, olivary; *d*, prostatic.

Gum-elastic catheters are made of webbing coated with copal varnish. Like the former, they follow the roof, but their flexibility depends upon temperature, and they can be bent to any shape. In cases of enlarged prostate, for example, if the point of the catheter is arrested by the median lobe, it can be tilted over it by withdrawing the stylet.

Black catheters are much more flexible, and follow the floor. The shape differs according to the requirements of the case; some have a minute bulb at the end, mounted on a slender neck, so that it can follow the most devious route; others are rigid and bent upward at an angle (*coudé*), so as to ride over an obstruction; others, again, are bent up twice in the same way (*bi-coudé*).

Vulcanized india-rubber catheters are mere rubber tubes, closed at the end and provided with a lateral opening; they are especially useful for patients who have to pass instruments for themselves, or where, as in cases of fracture of the spine, the urethra is absolutely insensitive. Celluloid instruments are too brittle to be of general use, but they are particularly suited for tying in the bladder, as they are much less affected by urine than the others.

The sizes of English instruments are arbitrary;* the smallest (¼) is about one-fifth of an inch in circumference; the largest (12), nearly seven-eighths. French ones are accurately graduated from one millimetre circumference up to forty.

Flexible instruments should always be preferred to metal ones. If there is a very tight stricture, and it is impossible to introduce a soft one, a small metal one may be tried, but, owing to the fineness of their points, they are exceedingly dangerous. An exception to this rule may be made in the case of an enlarged prostate of many years' standing, in which, after perhaps years of self-catheterization, retention has occurred at last. A full-sized, silver, prostatic one, with a very long curve, will, as a rule, ride over the obstruction, and squeeze its way between the swollen and congested walls of the urethra more easily than any other. Great care must be taken with the smaller black ones, as the varnish soon becomes cracked at the eye, and then the bulb is very likely to break off and be left behind.

Unless the state of the urethra is known, a moderate-sized instrument, 15 mm. to 17 mm., French, should be used to commence with. A larger one gives more pain, a smaller one may catch in a fold of the mucous membrane.

The patient should be in a recumbent position, with the umbilicus exposed, and the thighs slightly flexed and abducted. The instrument is sterilized and lubricated, preferably with Lund's oil (almond oil c.c. 32, castor oil c.c. 32, and pure carbolic acid c.c. 4); or, if there is a stricture, 4 c.c. of oil may be injected first. The operator stands on the left, and, holding the penis with his left hand, draws it well over the point of the instrument, putting the mucous membrane on the stretch, so as to obliterate its folds. The point of the instrument should follow the floor of the urethra for the first inch, to avoid a diverticulum occasionally left during development, after that the roof for the rest of its course.

In a normal urethra, either the catheter experiences no resistance at all, but merely sinks down of its own weight, or, after passing two or three inches, is quietly and slowly gripped, and held by the unstriped muscular fibre in the wall. There is no sudden stop (so that there is no resemblance to the resistance of stricture), and in a minute or two the instrument becomes free again; the fibres have tired themselves out.

As the bulb is reached, owing to the dilatation on the floor and the softness of the mucous membrane, the point of the catheter may catch against the lower edge of the opening in the triangular ligament. Very little force, then, at the end of a long lever, will drive it through the mucous membrane and make a false passage. The instrument must be withdrawn a little, and the handle gently lowered. If there is the least difficulty, the forefinger placed in the rectum will find the cause at once; but the utmost gentleness is required, or the point may slip over the edge in the right direction, but with a painful jerk. Withdrawing the stylet in a gum-elastic catheter has the same effect. Well-made black ones, with a sufficiently flexible neck, rarely cause this trouble.

The last obstacle is the neck of the bladder; very often the point catches on the floor again, even when the median lobe of the prostate is not enlarged, and the obstruction must be surmounted in the same way.

The best time for passing a catheter is in the morning, an hour or two before the patient gets up, so that he may remain warm. If this is not practicable, care at least should be taken that there is no exposure to cold afterward, and that micturition is not performed until it is absolutely necessary. With many patients,

[* Little used in America.]

especially those who have suffered from ague, or who have lived in the tropics, it is advisable to give quinine for several days previously, and, if the kidneys are sound, one small dose of opium; but care should be taken that the bowels are not confined. A sixth of a grain of morphia, hypodermically, a few minutes before the operation, diminishes the irritability of the urethra, especially if the injection is made in the region of the perineum. In all cases, except, of course, where there is urgency, a previous examination of the urine, both as to quantity and quality, should be made.

The passage of a catheter, especially for the first time, is a very painful proceeding, and may be followed by serious consequences. The *pain* is always worst as the instrument is passing through the membranous part; it is usually described as cutting or burning, and it may cause syncope. If it is very severe before this point is reached, there is probably some morbid condition of the mucous membrane. Fortunately, it can be prevented by injecting a few drops of a ten per cent. solution of cocaine down the urethra.

Other consequences arise from the effect upon the nerve-centres. Thus shock may affect the wall of the bladder, causing *retention* (especially if atony is already present); it may paralyze the vasomotor nerves of the kidneys, leading, according to its severity, to *hæmaturia*, or *suppression of urine* (particularly in cases in which the kidneys are already diseased); or it may involve the central nervous system; for *syncope* (probably from dilatation of the abdominal vessels) and sudden *death* have been known to follow.

Others, again, of which *urethral fever* is the most important, are of more doubtful origin. There are two chief forms of this: in the one there is intense shivering, with headache, depression, and vomiting; the temperature rises rapidly to 104° or 105°, and then begins to fall almost as quickly as it rose, while the patient lies in a state of utter prostration, sweating profusely; in the other, the temperature falls at first, then rises slowly until it reaches 102° or 103° F., sometimes with a rigor, but rarely a severe one, and, after a few hours, if the kidneys are sound, gradually sinks again.

This may occur after the operation, or more frequently after the first subsequent act of micturition, especially if it takes place soon. Those who have suffered from ague, or have lived in malarial districts, are particularly liable to it; exposure to cold is especially likely to bring it on, and there is no doubt that, though it does occur in those whose kidneys are perfectly healthy, it is more likely to happen, and much more likely to be followed by serious consequences, when they are diseased. In fatal cases intense renal congestion is usually found, but it is not improbable that this is a coincidence due to the effect upon the vasomotor nerves, and that rigors may occur independently of it.

Opinions differ with regard to its etiology. Harrison considers it due to the absorption from the urine of toxic alkaloids, which undoubtedly are produced in considerable quantities in the alimentary canal, and are excreted by the kidneys; but, on this theory, it is difficult to explain the non-occurrence of rigors after lithotomy and other operations. More probably it is a pathological exaggeration of the normal shiver which is so frequent during and immediately after micturition, and which is so strongly marked in infants, female as well as male, in whom it may be conjectured the spinal cord is, relatively to the brain, more active than it is in adults. This would bring it into the class of neurotic fevers; and its more frequent occurrence, and its greater severity when a catheter is passed for the first time, and when a stricture is still young and irritable, would admit of easy explanation. [It is significant of the origin of urethral fever that it seldom, if ever, follows the careful introduction of *sterilized* instruments.]

Other consequences that occur later are due either to mechanical injury, or to the products of septic or ammoniacal decomposition.

*Hemorrhage*, for example, from laceration of the mucous membrane, is not uncommon, and in cases of granular urethra or inflamed prostate is very difficult to avoid. In stricture especial care is required, as not unfrequently the mucous membrane is so softened from congestion that it gives way at once. If this occur

the catheter should be immediately withdrawn; the wound only makes the congestion worse, and diminishes by so much the chance of finding the orifice.

*False passages* are caused in the same way; they nearly always start either from the bulb or just in front of a stricture; there is a sense of resistance suddenly giving way, the patient complains of pain, and the catheter slips a little distance further, with an unmistakable sensation of grating.

*Inflammatory affections* of the urinary tract are still more common. All catheters, before using, must be thoroughly disinfected; it is not enough to dip them in carbolic oil of any strength. No part is exempt; *urethritis*, *perineal abscess*, *prostatitis*, and *epididymitis* may all occur, but by far the most common is *cystitis*. It is significant that ammoniacal decomposition of the urine often sets in for the first time within a week or two of the beginning of catheterization.

In a few instance *synovitis* has been known to follow the passage of a catheter. Whether it is to be regarded as pyæmic in origin or as the result of reflex nerve irritation is uncertain.

**Treatment.**—Local affections must be dealt with by themselves; so far as other complications are concerned, preventive treatment, by carefully preparing the patient and using the utmost gentleness, is the first consideration. Harrison speaks very highly of Fleming's tincture of aconite, in two-minim doses, for several days beforehand, and belladonna has been recommended. Sometimes, however, they will occur in spite of all precautions, and they cannot be prevented by anæsthetics.

The tendency to rigors may be checked, and if it is taken in time, as soon as the temperature begins to rise, actual shivering may certainly be shortened. A large cupful of hot tea should be given with .30 gramme of quinine, twenty minims of laudanum (if the kidneys are sound), and sixteen c.c of brandy; and the patient should be well wrapped up and made to lie down at once; but, if it has once commenced, it is doubtful if it can be stopped altogether. If signs of acute renal congestion set in, the patient should be placed in a hot bath for a few minutes, and then well wrapped up in blankets; the bowels should be opened as soon as possible, and dry cups applied to the loins. If there is a catheter tied in, it must, of course, be removed at once. Digitalis may be given with advantage, a teaspoonful of the infusion every hour, until there is some effect on the circulation, or a linseed poultice may be made with the infusion, and applied, as hot as possible, to the skin over the loins.

When, on the other hand, the attack is insidious, as in old cases of stricture and enlarged prostate, and marked chiefly by wandering delirium and great prostration, active treatment is out of the question; the kidneys are already diseased; the bladder is in a state of partial atony, and has not been able to empty itself perhaps for years, and the patient's reserve of strength is almost exhausted already. Very little can be done beyond general measures; the patient must be kept warm in bed, the diet must be light and unstimulating, and the bowels kept slightly relaxed. Opium is positively injurious; stimulants, especially spirits, should be avoided as far as possible, but often they must be given, and sleep must be obtained by means of chloral and bromide. This condition may last for a week or ten days and gradually pass away, or, especially when, owing to the state of the bladder, the catheter must be used, it may very soon terminate fatally. The pulse becomes quicker and feebler, the tongue is dry and brown, the delirium is more marked, the amount of urine secreted becomes less and less, the strength fails from hour to hour, and the patient sinks into a condition resembling typhoid.

FIG. 472.—Mode of Fastening Catheter in the Bladder.

A catheter occasionally requires to be tied in the urethra. This may be necessary where there has been great difficulty in passing a stricture, or when, owing to the presence of fistulæ or for other reasons, it is wished to drain the bladder and prevent urine passing along the urethra. In the former case the instrument should be secured so that the point lies just outside the bladder; in the latter, the end, of course, must lie

in it, but even then a certain amount of urine will always find its way by the side. The catheter should, if possible, be a flexible one, and celluloid instruments are to be preferred to others, as the urine does not decompose so readily. Even with them, the instruments should never be left longer than three days without being changed. Many patients cannot stand the continued irritation; the catheter acts as a foreign body, inflammation soon commences, and in a very short time the urea decomposes, and the end of the instrument becomes coated over with a layer of phosphates.

The simplest method is to pass two threads through the metal loops, one on either side, and fix them to the skin of the penis by a piece of strapping wound round it near its root. Or, as this plan has certain objections, and is not too secure, the threads (which must be double) may be knotted on either side about an inch and a half from the catheter; then, taking the two threads of one side, the one is carried over, the other under the penis, and knotted together on the opposite side so as to enclose in a loop; the ends are tied to the pubic hair. The other pair is then to be treated in the same way.

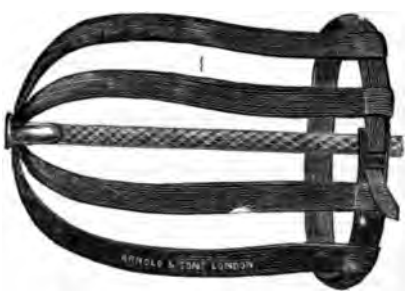


FIG. 473.—Arnold's Elastic Holder.

A better plan still is to fasten a bandage around the abdomen, and to attach a long tape to it on either side; these are to loop round the thigh. The end of each is carried across the abdomen, round the outer side of the opposite limb, and then brought up by the side of the scrotum, so as to be fastened to the waist-belt again. The tapes from the catheter are tied, one on each side, to the band in the groin, just opposite the root of the penis, so that it can assume any position that is convenient, without allowing the unstriped muscular fibre of the urethra to push the catheter out. Arnold's elastic holder is simpler and equally effective (Fig. 473).

## DISEASES OF THE URETHRA.

### INFLAMMATION.

Acute inflammation of the mucous membrane of the urethra is not common except as a result of gonorrhœa; mild forms of it, however, may be produced by other causes. Chronic inflammation may commence as such (as in the case of tubercular urethritis); or follow an acute attack which is prevented from subsiding by some constitutional or local cause, such as gout or stricture.

**Causes.**—1. *Mechanical injury:* the passage of sounds, for example, or the impaction of a calculus.

2. *Chemical Irritants.*—These may be the product of a specific germ (gonococcus); or they may be present in foul septic discharge; or they may be excreted by the kidneys in the urine—*e.g.*, cantharides and uric acid.

3. *Syphilis* and *tubercle.*

### ACUTE URETHRITIS.

The most intense form is gonorrhœa, an acute suppurative inflammation of the mucous membrane due to contagion, and probably to the presence of a specific germ. It always begins as a local disease, but sometimes the constitution becomes affected, and secondary troubles, peculiar to itself, make their appearance in distant parts of the body.

*Gonorrhœa.*—The germ (gonococcus) is [a diplococcus] found upon the surface of the epithelial cells in gonorrhœal pus, each individual coccus being

placed at a distance equal to its own diameter from its fellows. It is stated to be always present, and to be found in the discharge of ophthalmia neonatorum, as well as in the fluid of gonorrhœal arthritis and conjunctivitis. Cultivations of it have been made in gelatine, and these are equally active. Vaginal discharges [containing other pyogenic organisms] can infect the urethra and even the conjunctiva, and cause inflammation.

There is no doubt that the action of the germ is greatly favored by different conditions. Certain people seem to enjoy immunity, or, if they are attacked, the inflammation is of the most transitory character. The first attack is usually by far the worst and, so far at least as out-patient practice is concerned, it is rare to see it very severe in any one over five-and-twenty. Intense and prolonged sexual excitement, too frequent intercourse, and irritating conditions of the urine, such, for example, as that produced by the free use of alcohol, of themselves sometimes cause a muco-purulent discharge, and certainly they render the mucous membrane more sensitive. Asparagus and new sherry are stated to have a peculiarly strong influence in this direction.

**Symptoms.**—The period of incubation is short, from four days to a week. The first sign is a slight redness at the meatus with an increased secretion of mucus, a sense of soreness or itching, and a certain amount of smarting during micturition. In the course of the next two days these symptoms become more marked, and more and more of the urethra is involved, until the whole mucous membrane is in a state of the most intense inflammation. The meatus is swollen,

FIG. 474.—Gonococcus. (Bumm.) *a*, from a pure culture. *b*, from a blennorrhœic conjunctival secretion; an epithelial cell covered with cocci: a pus cell completely filled with cocci; a free mass of cocci in close proximity to a pus cell (Seibert). Oc. 2. *c*, scheme of development of gonococci. (*From Senn.*)

red, and pouting, the prepuce œdematous, the glands turgid and shining, the whole penis enlarged and soft, with the veins congested and prominent. Sometimes red lines, due to the inflamed lymphatics, can be seen in the skin, and the glands in the groin, especially those just below Poupart's ligament at the inner end, are swollen and tender. At the same time the discharge increases until it flows away continuously, and its character changes from glairy mucus to thick, cream-colored, yellow, and even, in severe cases, greenish pus.

Increased frequency of micturition occurs very early; at first it is probably reflex, but later it is due to extension of the inflammation toward the neck of the bladder; and each act is attended by a scalding, burning pain, partly caused by the tension on the mucous membrane, partly by the irritation of the acid urine. Sometimes, as the swelling and congestion increase, the stream is obstructed, and if the prostate is attacked, retention is almost sure to occur. Malaise and fever are usually present during the acute stage, and at night, even when the penile part only is involved, rest may be disturbed by chordee. As the patient grows warm in his bed the penis is liable to become erect; owing to the infiltration in the corpus spongiosum, it cannot expand evenly, and the inflamed and tender fibrous tissue is stretched until it causes the most intense suffering. If the inflammation extends to the deeper part of the urethra, where it is fixed and surrounded by fibrous tissue, the pain is even more severe, and there may be high fever; the perineum throbs and burns; there is a sense of weight in the pelvis, and a constant aching across the loins; and the skin over the scrotum and testes is sometimes so tender that the patient can scarcely endure being touched.

The acute stage lasts a week or ten days. As it begins to subside, the scald-

ing becomes less intense; the throbbing ceases; the frequency of micturition disappears, and the discharge diminishes in quantity, loses its greenish color, and becomes less thick. If no complication is present it may cease altogether in about six weeks; more frequently it persists for some time, not more than a few drops of glairy mucus in the twenty-four hours, or perhaps merely sufficient to glue the sides of the meatus together in the morning; but with every indiscretion, irregularity of diet, sexual excitement, undue exercise, or alcoholic indulgence, returning and becoming muco-purulent for a few days.

Sometimes it becomes chronic. The mucous membrane becomes rough and granular, covered with hypertrophied papillæ; or the loose and vascular tissue that surrounds it becomes dense and hard, as the lymph that fills its meshes is organized; in either case the change, slight as it is, is sufficient to maintain a certain degree of irritation; there is a constant discharge of thin mucus from the meatus (gleet), and more and more lymph is poured out until the diameter of the urethra is narrowed, and a stricture is formed which, itself an irritant, keeps up the inflammation, and continues to get firmer and firmer the longer it lasts.

**Complications.**—(*a*) *Hemorrhage* is not uncommon, owing to the overloaded condition of the thin-walled vessels in the mucous membrane, but, unless very profuse, it need not excite alarm; the green color of the pus is due to hæmoglobin. *Chordee* and *retention* have been already mentioned.

(*b*) The most common are caused by extension of the inflammation to structures near. *Balanitis*, *posthitis*, *phimosis*, and *paraphimosis* are of frequent occurrence; *warts* rarely occur until the irritation has lasted some length of time. *Abscesses* are not so often met with, but they occasionally originate in the mucous follicles, especially those of the fossa navicularis; or they may occur independently of the mucous membrane, in the lymph that is poured out around it. If the suppuration is in the region of the bulb, or on one side of it, in connection with Cowper's gland, it often spreads a considerable distance before coming to the surface. *Prostatitis*, with complete retention, and *cystitis* often follow; occasionally even the pelvis of the kidney and the peritoneum are involved. *Epididymitis*, from extension down the vas deferens, is not so common in the acute stage as later, when gleet sets in. *Bubo* and inflammation of the lymphatics may occur at any time, especially if the patient will not rest quiet; and even pyæmia may break out and prove fatal, starting, in all probability, from some ulceration of the mucous membrane.

(*c*) Others are caused by direct infection. Of these, *conjunctivitis* is the best known and the most serious (*gonorrhœal ophthalmia* and *ophthalmia neonatorum*); and the mucous membrane of the nose and of the rectum may be also infected. [Rectal gonorrhœa is very common in women, from overflowing gonorrhœal discharge from the vagina.]

(*d*) Another variety is the result of constitutional infection, and does not occur, so it is said, in simple urethritis, however severe it may be. The fibrous tissues (particularly the joints) are the parts most liable to be attacked, but sometimes the sclerotic, the plantar fascia, the tunica albuginea of the testis, and the sheets of fibrous tissue in the loins suffer as well. Its connection with gonorrhœa is shown by the fact that not only does it return with each fresh attack, but that, if from any indiscretion there is a relapse or an increase in the amount of discharge, there is frequently at the same time a fresh outbreak of the secondary inflammation. When it is acute and attacks several joints, it may be distinguished from rheumatic fever by the absence of the sweating and the thick, white furred tongue, and by the rarity with which cardiac complications occur; but the relation that it bears to gout, particularly to the chronic rheumatic form, is much more uncertain. There is no doubt that it is more likely to break out in those who are subject to this complaint; or in whose families there is a well-marked history of it; and I have seen several cases which strongly bear out Hutchinson's contention that, in patients who are distinctly gouty or rheumatic, any urethral discharge, specific or not, may give rise to symptoms similar to those of gonorrhœal rheumatism. Suppuration rarely

occurs; but, if it does, it is impossible to draw a definite line between gonorrhœal arthritis and pyæmia. A similar affection occurs not unfrequently in women who are suffering from chronic leucorrhœa; and ophthalmia neonatorum, according to Lucas, may give rise to something of the same character. For a further description see Diseases of Joints. [Bacteriologists are now generally agreed that arthritis complicating gonorrhœa is caused by metastatic infection.]

*Acute urethritis*, of a similar description, but much less intense, may be caused by infection from leucorrhœal or menstrual discharges. When due to mechanical irritation, such as the passage of a catheter or the impaction of a calculus, it rarely lasts more than a day or two. If there is a stricture the discharge may be profuse at first, but it is rarely purulent; and if the cause is removed, the symptoms soon subside. Occasionally, however, the inflammation extends, and epididymitis and other complications occur, as in gonorrhœa.

*Gouty urethritis*, like inflammation of the bladder, is not uncommon when the urine is loaded with uric acid. Usually it is an extension of the inflammation from the neck of the bladder, and the discharge is preceded for some days by irritability, increased frequency of micturition, and sharp, cutting pain at the end of the penis. It is most common in stoutly-built, middle-aged men, addicted to alcohol, but it is met with in women also; and a somewhat similar form, dependent upon malassimilation, and attended with a deposit of uric acid crystals, is not uncommon among poorly-fed children, and often gives rise to the suspicion of calculus. Unless it is the residue of a gonorrhœa kept up by the condition of the urine, it rarely happens that there is much discharge, or that it is purulent. Berkeley Hill has described a very obstinate form analogous to this, *eczematous urethritis*, occurring under much the same conditions, but associated with eczema of the skin. The surface of the glans is reddened and tender, and the anterior part of the urethra appears to be affected in the same way; the mucous membrane is bright red in color, though it does not bleed easily, and the discharge is scanty and milk-white. Epididymitis, prostatitis, and other complications may occur in gouty urethritis as well as in the rest; but, in addition, inflammation may attack the joints, the eye, the testis, the fibrous tissue of the back, the sheaths of nerves, and the plantar fascia, just as in gonorrhœa; and unless the history, the condition of the patient, and the state of the urine are carefully investigated, it is very difficult to distinguish one from the other.

*Tubercular urethritis* is generally secondary to inflammation of the bladder, and the urethral symptoms are completely overshadowed by the intense irritability and the fearful burning pain at the neck when it contracts. The discharge is generally scanty in amount, and unless the anterior part of the urethra is involved, is only seen when the urine washes it down, but it is often stained with blood coming from the surface of the ulcers when the muscles are contracting. The sense of smarting during micturition is sometimes very severe; and, owing to muscular spasm, is apt to continue for a long time after the act is finished; and the passage of a sound or catheter gives the most intense pain when the ulcers are reached. Cicatrization sometimes occurs, and gives rise to stricture; but, as a rule, the bladder and other organs are involved, and the patient rarely lives long.

*Syphilitic Urethritis.*—A scanty discharge, with a certain amount of soreness along the urethra, is not infrequent in early secondary syphilis, caused, in all probability, by the eruption of a few roseolous spots upon the mucous lining. As a rule it disappears very rapidly under specific treatment.

**Treatment.**—As gonorrhœa commences by infection at the meatus, it has often been proposed to cut short the attack as soon as the redness first makes its appearance by the use of a strong astringent, limited to the anterior part of the urethra. Tannin or nitrate of silver (gramme .30 ad c.c. 32) is generally recommended; and so long as the penis is carefully compressed immediately behind they may be used without danger, but it is doubtful whether they are of much service.

1. *The Acute Stage.*—Local applications are better avoided so long as the

intense hyperæmia with profuse purulent discharge and the severe pain continue. The patient should, if possible, be kept in bed; the absolute rest obtained in this way is better than anything else. The bowels should be kept freely open, the diet carefully regulated, all forms of highly seasoned food and sauces, pepper, vinegar, tea, coffee, rhubarb, and asparagus being forbidden, and as much fluid (barley water, milk, etc.) allowed as the patient wishes; but no alcohol. Claret and very weak gin and water are perhaps the least injurious; champagne, sherry, and beer will often bring back a temporary gleet months after its last appearance. If the urine is acid and irritating, alkalies may be given with sedatives, such as hyoscyamus; but if the bicarbonates are used they should always be taken during digestion, not while the stomach is empty. The dressing of the penis itself should be light and frequently changed; anything that prevents evaporation, or that absorbs the pus and dries upon the meatus so that the discharge cannot escape, is injurious. A soft linen bag in which it can hang freely, with some wood-wool at the bottom to soak up the discharge, is as convenient as anything. Dressings retained under the prepuce are liable to be very irritating; if the glans cannot be exposed it is better to introduce a soft rubber tube by the side of it as far as it will go, and irrigate its surface thoroughly several times a day with lead lotion. The antiseptic treatment by means of bougies, though it promises well, is not so successful in practice.

If the hyperæmia is so great as to threaten retention of urine it may sometimes be checked by free leeching in the perineum, or by the application of Leiter's coil, with ice-cold water. If it come on in spite of this, a soft rubber catheter of moderate size must be passed, and, if necessary, this must be repeated three times a day. A morphia and belladonna suppository the last thing at night, or a hypodermic injection in the perineum, will usually stop chordee. Bromide of potash in full doses is also very useful, and camphor is said to be of value. The patient should be directed to take a warm (not hot) sponge bath, at night, to avoid late meals, to cause the bowels to act freely before retiring to rest, and to have only the lightest clothing on while in bed. Abscesses around or in connection with the urethra should be opened freely and as soon as possible, or they may degenerate into troublesome sinuses. They are most common near the meatus, starting from the follicles in the fossa navicularis, or else forming by the side of the frænum; sometimes, however, they occur further back in connection with Cowper's glands. They may burst into the urethra, but unless there is a stricture present it seldom happens that the fistulous opening persists.

2. *The Subacute Stage.*—When the active hyperæmia and scalding have subsided, or if the inflammation is only subacute from the first, more active measures may be adopted. Copaiba and cubebs may now be given with advantage; or if they do not agree with the patient, gurjun, sandal-wood, or eucalyptus oil. These all appear to act locally, the resin being excreted by the walls of the urinary passages. Copaiba, when it can be tolerated, is perhaps the most efficacious; 2 c.c. doses may be given, rubbed up with burnt magnesia in the form of a bolus, or with sulphuric acid, or better still, if the patient will take it, with liquor potassæ, with which it forms a kind of soap. Harrison has shown that it is much more effectual when given with an alkali than in the form of capsules. Cubebs are more stimulating, and may be taken with it. The best time for administration is either an hour before meals or three hours after. In some patients, however, copaiba produces a characteristic roseolous and even papular eruption upon the skin (copaiba rash); in others it disturbs digestion to such an extent that it cannot be endured; and it even has the credit of causing hæmaturia. Few can stand it for any length of time, and if it does not produce a definite improvement in the course of a fortnight, it is better to stop it altogether. Such patients are often more benefited by tonics.

In the majority of instances, gonorrhœa will cease without the use of injections; but in the subacute stage, when the discharge shows no signs of abating, and still more when a chronic gleet has set in, they may be used with advantage.

So long as there is extreme hyperæmia they are positively harmful. The ordinary glass syringe is useless, unless the mischief is confined to the fossa navicularis; the object is to wash out the discharge from off the mucous membrane, so that it may not remain stagnant in its folds or recesses, and to apply a very mild astringent to the surface. Durham's tube, which can be introduced as far as the bulb, and which is provided with openings so that there shall be a recurrent stream, is the best, but in its absence a small flexible rubber catheter may be employed. This should be introduced as far as necessary, and then connected with a Higginson's syringe. Hot water may be used first to wash out the urethra and then a very mild astringent. There is no fear of any injection penetrating as far as the bladder, if ordinary precautions are taken, and it should never be sufficiently strong to do any harm if it does. Chloride of zinc (.03 ad 32 c.c.), sulphate of zinc (.06 ad 32 c.c.), acetate of lead (.12 ad 32 c.c.), tannin, mercuric chloride, subnitrate of bismuth (not suspended in mucilage), and many others are of use; and very often it is of advantage to change from one to the other. The bulb and the fossa navicularis may be thoroughly douched in this way every night, or, if no progress is made, night and morning; the application causes a certain amount of smarting, but if it is really painful, either the injection is too strong or the inflammation still too acute.

In tubercular urethritis everything must be done to maintain the strength of the patient and assuage, as far as possible, by morphia and belladonna, the irritability of the bladder. If the urine becomes ammoniacal, relief may be obtained by opening the bladder in the perineum and draining it. Iodoform seems to be the best local application, as in tubercular cystitis. Local applications are rarely of service when urethritis is due to gout; the urine must be rendered as unirritating as possible, the bowels kept open with mercurial purges, and careful attention paid to diet and exercise. When the urethritis is simply caused by the irritation of the urine it can easily be cured; but if there is gouty inflammation of the corpus spongiosum or of the prostate, the condition is exceedingly obstinate, and epididymitis and other sequelæ are not unlikely.

### Chronic Urethritis.

Chronic urethritis rarely occurs unless there has been an acute attack; the inflammation subsides up to a certain point, and then from some cause, local or constitutional, becomes stationary, the discharge persisting as a gleet, sometimes disappearing for a few days, and then returning again almost as bad as ever. Even in healthy persons, the mucous membrane of the urethra is always peculiarly sensitive after an acute attack; the least indiscretion for months after brings back a certain amount of gleet; and a very slight cause is sufficient to keep the irritation up permanently. Chronic inflammation of this description is the main cause of stricture; for months, and even years, minute quantities of lymph are constantly being poured out into the mucous and submucous tissues; as it becomes organized, it gradually renders them so dense and hard that at length a definite organic obstruction is developed.

The reason is often difficult to find. Sometimes it appears to be due to general debility rather than anything else; the patient's health gives way; the mucous membrane remains soft and relaxed, without any great local change, and the catarrh becomes chronic, as it occasionally does in other parts of the body. In other cases it may be traced to errors in diet or to faulty modes of living. More frequently it is dependent upon some local affection, very slight, perhaps, but quite sufficient to keep up irritation. Small warts, similar to those on the prepuce and behind the glans, can be seen sometimes just inside the meatus. Pouches and dilatations of the mucous membrane, possibly originating from inflamed follicles, are found occasionally, especially in the fossa navicularis and in the region of the bulb. These serve to collect a small quantity of urine, which begins to decompose and act as an irritant before it is washed away. Chronic

inflammation of Cowper's glands sometimes occurs in the same way. A granular condition of the surface is still more common, especially in the region of the bulb. It closely resembles in appearance that which is left after repeated attacks of conjunctivitis; the mucous membrane is rough and tender when touched; the color is bright red; and it is covered with small papillæ. Slight strictures, again, are occasionally the cause; the exudation of lymph is not sufficient to affect the stream, but for all that it renders the mucous membrane hard and unyielding, so that it cannot unfold itself as the urine is passing. Finally, in some cases the whole of the urethra in front of the triangular ligament continues to secrete a profuse mucopurulent fluid, without its being possible to find any local or constitutional cause to account for it. Harrison has described several such in which the passage appears to have degenerated into a chronic suppurating sinus, which could not be drained, and which, in spite of injections, and in one case of internal urethrotomy,

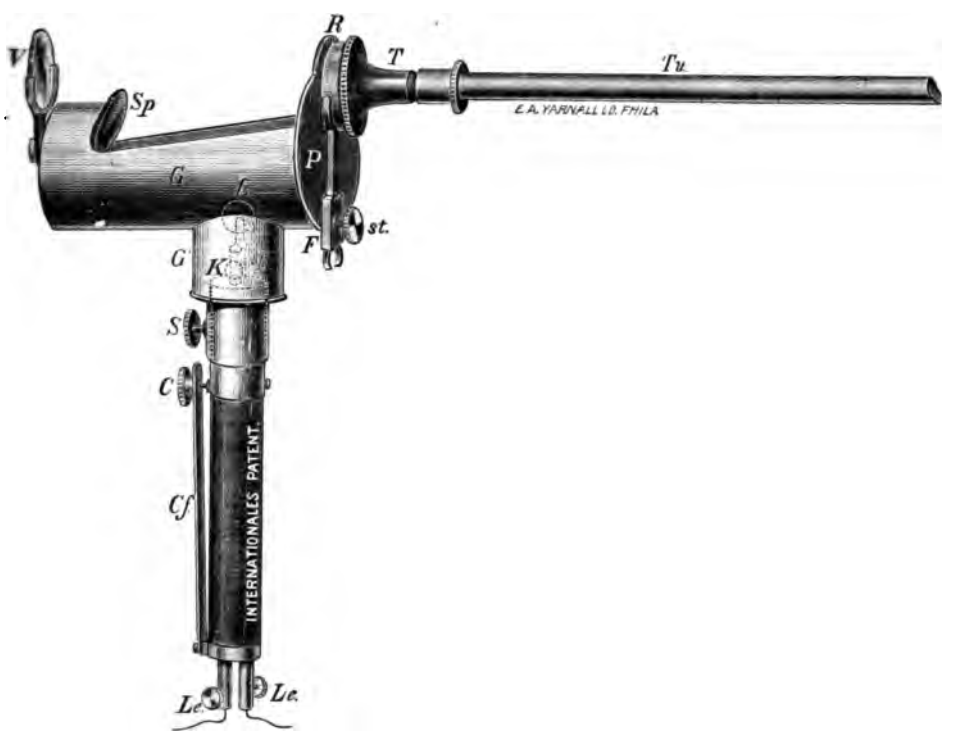



FIG. 475.—Leiter's Panelectroscope. *L*, Lamp; *Sp*, Mirror; *V*, Lens for correcting any defect in the observer's vision.

declined to improve in any way. At last they were cured by giving the urethra perfect rest for a month, opening it behind in the perineum, and draining off all the urine from the bladder, so that no drop should flow along it.

An absolute diagnosis in such cases can only be made by means of an endoscope. Leiter's panelectroscope is perhaps the most convenient; it carries a small incandescent lamp in the vertical portion, so arranged that its rays are concentrated by a mirror and reflected down the tube, while the observer's eye looks over the upper edge. It is an additional advantage that, with this instrument, applications may be made to any part of the urethra that requires them, without withdrawing the tube.

Constitutional treatment should be thoroughly tried. If the patient is broken down in health and strength, tonics and sea-air often prove efficacious; or, if there is evidence of gout, alkalies may be given, or the patient may be sent for a

time to a suitable watering place, so that the mode of life may undergo a complete change. The diet should, in all cases, be carefully regulated, especially as regards the amount of alcohol; and, according to some, smoking is particularly injurious. At the same time, the deeper part of the urethra should be thoroughly washed out with some mild astringent, as in chronic gonorrhœa, only this should be done, not once a day, but after each act of micturition. It is no use injecting the meatus unless it is known there is a tender spot in the fossa navicularis; the only method is to pass a soft rubber tube down as far as the bulb, and with Higginson's syringe gently douche the whole length from behind, varying the nature of the application every week or ten days. If this does not succeed, a full-sized bulbous instrument should be slowly and carefully passed, and then, after the spasm has subsided, withdrawn again. Sometimes this of itself is sufficient: the muscular fibre of the urethra is stretched; the spasm ceases for a time; the mucous membrane gets a certain amount of rest, and the irritation has a chance of subsiding. The same treatment is often successful in obstinate cases of neuralgia, which persist without anything being found to account for them.

Most frequently, however, the persistence of the symptoms is due to some local change in the mucous membrane which requires special treatment. The method, of course, must vary with the lesion; small warts in the meatus may be snipped off or touched with mild caustics; if the mucous membrane is rough and granular, a moderately strong astringent may be applied to the surface by means of a syringe, as in chronic prostatitis. Glycerine and tannic acid I have found very useful to commence with; if this fails, nitrate of silver (.30 ad 32 c.c.) may be tried. Sinuses should be distended with a similar injection, after each act of micturition, or, if near the meatus, they may sometimes be laid open. There is a congenital diverticulum occasionally present in the fossa navicularis, which rarely gets well until it is treated in this way. Its existence may be suspected when there is a feeling of pain in the glans at the commencement of micturition, or when squeezing the glans suddenly sometimes causes a few drops of discharge to make their appearance; but, as its opening lies toward the bladder, it can only be detected with the endoscope, or with a probe, the point of which is bent back upon itself. Finally, if there is any resistance to the passage of a sound, especially as it is being withdrawn, suggesting the presence of a commencing stricture, a full-sized instrument should be passed once a week, until it is no longer grasped.

## STRICTURE.

Stricture of the urethra may be congenital or acquired. The former is very rare and only occurs at the meatus, or within a short distance of it; the latter is met with in every part except the prostatic, and is always the result of inflammation.

Stricture, in the true sense of the term, must be a structural alteration in the wall of the urethra; there may be only a certain degree of roughness and unevenness, so that the mucous membrane does not unfold itself smoothly when urine is passing; or thickening and exudation in the submucous tissue, leaving the surface smooth; but in every case there is a definite and persisting change. Spasm and congestion are always present in addition, owing to the vascularity of the part and to the amount of unstriped muscular fibre, especially in the region of the bulb; and in certain conditions (such as congestion of the prostate) these of themselves are sufficient to cause obstruction and retention; but they are in reality symptoms, not diseases, and it is better to reserve the term stricture for an organic change.

**Causes.**—*Gonorrhœa* is by far the most common. A slight attack merely leaves the surface tender with enlarged hypertrophied papillæ; when it is more severe and long continued, a large amount of exudation is poured out into the submucous tissue; and gradually, as it becomes organized, it constricts the canal more and more. Ulceration of the surface and cicatrization are rare.

*Injury.*—Rupture of the urethra may cause stricture of a very obstinate character if suppuration occurs, owing to the dense mass of cicatricial tissue formed.

Impaction of a calculus, median lithotomy, when the urethra is torn, and caustics, are occasional causes.

*Syphilis.*—Primary sores not unfrequently cause stricture at the orifice; and occasionally, in the later stages, ulceration of the mucous membrane or gummatous exudation into the corpus spongiosum, leads to the same result. A few instances are on record in which stricture has followed tubercular ulceration.

Many different terms are used to describe strictures, according to the prominence of special features. If there is a band of lymph stretching across the canal from side to side, it is called a *bridle;* when there is a thickening round the whole circumference, as if a piece of string were tied around it, it is *annular;* and if the base is much infiltrated, *indurated.* Sometimes, especially in old cases where there are fistulæ, this is so hard and extensive that the stricture is said to be *cartilaginous.* Those are *irritable* where rigors occur whenever a catheter is passed; and *resilient* or *elastic* if the constriction returns at once after dilatation. Very often they are *tortuous;* and sometimes, but probably only when the wall of the urethra has sloughed, they are *impermeable.*

So far as concerns the question of treatment, the most important distinctions are the locality (whether near the meatus or deep down in the bulbous part), the length of time the stricture has been there, and the amount of induration. If recent, the infiltration is slight, and the lymph to a great extent is still soft and cellular; in older cases, those, for instance, of some years' duration, an inch or more of the wall of the urethra may be converted into a dense cicatricial mass, extending into the corpus spongiosum, and feeling from the outside as hard and resistant as cartilage.

*Locality.*—Stricture never occurs in the prostatic portion of the urethra. The most common situation is said to be at the bulb, though in a very large number of instances it is really in front of this. Various reasons have been offered in explanation. Some consider it due to this portion of the urethra being horizontal when the body is erect; the discharge does not flow away, and, acting as an irritant to the mucous membrane, causes a greater amount of lymph to be poured out here than elsewhere. Others have assigned it to the angle that the penis forms in front of this spot, so that the walls are pressed closely together. Probably the real reason is the unusual amount and the looseness of the mucous and submucous tissues allowing a larger quantity of lymph to collect. The urethra is only patent for the moment that the urine is passing along it; except at this instant, its walls are in contact and thrown into longitudinal or spiral folds. If it becomes inflamed, these are thickened, swollen, and pressed together; and if the lymph that is poured out is allowed to become organized, the canal is permanently narrowed.

When traumatic, the seat of the stricture depends naturally upon the injury. Usually the urethra is torn a little in front of the membranous part or just where this joins the bulb. Those due to venereal sores are nearly always at or close to the meatus.

In most instances stricture is single, but it is not uncommon to find two or even more, and in a few cases as many as six distinct ones have been described as existing at the same time.

**Pathology.**—*Post-mortem* a stricture appears as a contraction of part of the urethra. Sometimes, especially when near the meatus, there is a band stretching across from one wall to the other, or a distinct cicatrix on the sides; more frequently there is an opaque white constriction, extending around the whole circumference, dense and indurated, and varying in thickness in different parts, so that the canal is narrowed, tortuous, and irregular. In many cases the mucous membrane is affected equally with the submucous tissue, its elasticity is entirely gone, and it is fixed firmly; but sometimes it can be dissected off, and opened out to its full extent, almost unaltered. On the other hand, in old cases, especially in the region of the bulb, the mucous and submucous coats, the corpus spongiosum, and even the areolar tissue outside, are converted into a gristly cartilaginous mass, in which scarcely a trace of any of the original structures can be found.

In front of the stricture the mucous membrane is swollen, reddened, and hyperæmic, ready to bleed at the least touch, and the unstriped muscular fibre is in a state of tonic contraction, but this, of course, disappears *post-mortem*. The surface, however, is rough and irregular, with small granulations; usually it is discolored from old hemorrhages, or it is excoriated or covered over with mucus, and the normal folds of the urethra are confused and sometimes altogether lost.

Behind, the effect upon the other organs is soon apparent. Owing to the increase in the pressure the urethra becomes dilated, the orifices of the small ducts enlarge, some of the bands of muscular fibre increase in size, leaving between them depressions in the thinned and stretched mucous membrane, similar to those found in the bladder, only on a much smaller scale, and at length the interior may become reticulated or studded with little pouches, which act as receptacles for decomposing urine. Then the bladder becomes affected. If the obstruction is sudden and extreme from the first, too great for the muscular coat to overcome, it yields and becomes atrophied, the cavity enlarges, and the walls become thin and soft. If, on the other hand, the resistance is of slow formation, so that the work increases gradually, and if there is any irritation, so that the bladder is constantly contracting, the opposite effect is produced—at first, at any rate; the walls grow thick and rigid, the cavity diminishes in size, the muscular coat hypertrophies, and the fasciculi stand out under the mucous membrane in ridges, like the musculi pectinati of an auricle, leaving between them deep depressions. As time passes, these changes become more and more marked; each time the bladder contracts the urine is driven into the depression between the ridges, until they become deep enough to project on the outside under the serous covering, and then they soon enlarge into *tunicary hernia or sacculi*. There is no muscular fibre in their wall; they cannot resist or empty themselves: with each contraction the urine is driven into them, distending them in all directions, and not unfrequently they become almost as large as the bladder itself, with which they communicate by a very narrow opening (Fig. 433). The same influence is felt by the ureters and the pelvis of the kidneys; there is no regurgitation, but, owing to the great increase in the pressure, they become more and more distended, at the expense of the glandular part, until, in the case of the kidneys, the secreting power is seriously impaired.

FIG. 476.—Stricture of Urethra showing Fasciculated and Contracted Bladder; Dilated Prostatic Urethra with Reticulations consequent upon Distention of the Prostatic Follicles; Ulceration above the Stricture, and orifice of false passage below.

The effect, however, is rarely limited to mechanical dilatation. I have known cases in which, though the bladder was distended to the umbilicus, and though it had been in that condition for months, and even years, the urine on being drawn off was normal and acid, but this is the exception. Inflammation nearly always breaks out sooner or later, probably extending upward from the stricture. Ulceration may then set in behind, in the dilated part of the urethra, and lead to extravasation of urine: an abscess may form in the substance of the stricture tissue and burst in the perineum, leaving behind it a fistulous opening; suppuration may occur around the prostate, or the inflammation may spread down the vas deferens to the testes.

The bladder is usually the first involved, but the ureters and kidneys follow

suit very soon. At first there is merely catarrhal cystitis and pyelitis, but when the urine becomes more irritating, and especially when it decomposes, the effect is much more marked. The mucous membrane becomes ulcerated and coated with phosphatic debris, the pus spreads along the connective tissue in the substance of the kidney, numbers of minute abscesses form under the capsule and in the cortex, the apices of the pyramids are destroyed, and at length the kidney is almost disorganized; it is reduced in size, hard, and irregular on the surface, from old interstitial inflammation; the capsule is adherent; when it is stripped off there are numbers of little abscesses beneath; and the pelvis is enlarged, irregular in shape, blackened and ulcerated on the surface, and filled with a mixture of stinking pus and phosphatic debris.

**Symptoms.**—(*a*) *Those Due to the Obstruction.*—Complete retention is sometimes almost the first. In recent strictures the urethra is often peculiarly sensitive; spasm and congestion may be caused by the slightest irritants and close the channels altogether, even though the opening is still fairly wide. More frequently the outflow is merely impeded. Simple twisting or flattening of the stream may be due to the shape of the meatus, and means nothing, but if it is forked or much reduced in size or force it is very suggestive. In old cases, when the obstruction becomes very great, the stream may fail completely, the urine only coming in drops. Generally, after micturition is finished, the last few drops flow away of themselves, owing to the action of the urethral muscles being interfered with but this happens also in enlargement of the prostate, and even after exposure to cold.

(*b*) *Those Due to Inflammation.*—Usually there is a slight muco-purulent discharge (gleet), especially in the morning, or after exercise. In general it is only a drop or two, and many patients are unaware of its existence, but it may cause great annoyance. Pain is seldom felt, unless there is some inflammatory complication or the urethra is forcibly distended. In cases of long standing there is usually thickening about the corpus spongiosum or the bulb. Spasm is rarely wanting, and often leads, especially in recent strictures, to complete retention. As they grow old and cartilaginous, either the muscle loses its power or the surface its sensibility, but in this there is a strong personal element, and the urethra is much more sensitive, especially when inflamed, in some than in others. Any slight irritant, an excess of uric acid for example, alcohol, sexual indulgence, exposure to cold or wet, constipation, or even an inflamed pile, may set up sufficient spasm to render the closure complete.

This is of great consequence in relieving retention due to stricture. If a catheter cannot be passed at once, teasing the stricture only makes the spasm and congestion worse, while relief (for a time, until more efficient measures can be adopted) can almost always be obtained by hot baths and other measures that procure muscular relaxation.

The course of stricture, if left to itself, is simply from bad to worse. Temperament and the position of the stricture are of some influence; deep ones, that is to say, are worse than those near the meatus, but the chief element in prognosis is the condition of the kidneys. As the bladder becomes involved, micturition becomes more frequent and the straining greater; the patient has to rise at night; retention is always liable to occur; at first it may be relieved with an instrument or baths and purgatives, but each time it leaves a permanent change for the worse; pain becomes a more prominent feature; there is a constant, dull, aching pain in the loins, and rupture, hemorrhoids, and other troubles follow. Then the kidneys become affected, the specific gravity of the urine diminishes, the amount of solids is lessened, the patient grows weak and anæmic, digestion fails, chills and feverish attacks are of common occurrence, the skin becomes harsh and dry, and the health breaks down completely. Urinary abscess is of common occurrence, extravasation may take place, calculi may form, inflammatory troubles of all kinds may follow, or, if none of these things happen, the quantity as well as the quality of the urine diminishes, the albuminuria becomes more pronounced, and death is

caused either by urethral fever and suppression, or more frequently by some intercurrent disorder, such as pneumonia or pleurisy.

**Diagnosis.**—The diagnosis of stricture can only be made by sight or touch. With the exception of those at the meatus, either an endoscope or a sound must be employed. Each has its separate uses; one cannot replace the other. As most patients do not apply for relief until the narrowing of the canal is advanced, the sound is of greater service; but in earlier cases, where there is little organic change, and where the symptoms are mainly due to spasm and congestion, the endoscope tells much more. With the one it is only possible to say that there is a tender spot in the wall of the urethra, giving rise to spasm, congestion, and pain; with the other, the size, locality, and nature of the lesion can be accurately determined, in most cases with the greatest ease.

For diagnosis, metal sounds are preferable to flexible ones; the information they give is more precise. For treatment this does not hold good; a soft, flexible instrument can often find its way along the folds of the mucous membrane into the orifice of a stricture, while a rigid one becomes entangled at once. The best are of steel, as this takes a higher polish, and the curve should be sharp and abrupt. The smaller sizes may be of the same diameter throughout, but in the case of the larger ones the shaft is slender, so that it may move freely in the urethra, and the end expanded like a bulb. This may be either conical or ovoid; the former are used for ascertaining the length of a stricture, in conical shape passing readily through the narrowed part; on being withdrawn the shoulder catches at once. Unfortunately, English sizes are so arbitrary that it is scarcely possible to be accurate with them; the smallest is usually about one-fifth of an inch in circum-

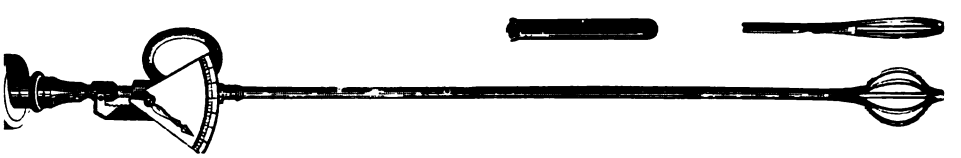


FIG. 477.—Otis's Urethrameter.

ference, the largest (No. 12) nearly an inch. The French, on the other hand, are graduated accurately from one millimetre in circumference up to forty.

*The Size of the Urethra.*—There is a distinction between the normal diameter of the urethra during life, and the size to which it can be stretched without injury. Even when urine is passing in full stream the walls are contracted and maintain a certain degree of tonic pressure upon it so as to ensure its ejection; and they can be stretched, so far at least as the penile part is concerned, far beyond this. If a stricture is to be considered cured, it must be dilated until its width is as great as that of the adjacent part of the urethra when distended to its utmost. Clearly, if it contracts again, it will close much sooner if it has been dilated to No. 21 F. than if it had been dilated to No. 28 F. But this is not all: if it is in a part which can be distended more widely (even though its diameter is equal to that of the rest when urine is passing), it remains an obstruction still; the walls are hard and rigid instead of being soft and flexible, and they must be stretched until the induration is gone and the lining membrane falls into its natural folds again. How wide this may be differs in each part, and probably in each person; and the only way to ascertain it is, either by carefully exploring with bullet sounds of different sizes (enlarging the meatus if necessary to admit them), or by measuring it directly with a urethrameter. The most convenient form of this instrument is that invented by Otis; it consists of a straight shaft, carrying at its end a small expanding bulb. The size of this can be increased or diminished by means of a screw near the handle. The measurement is recorded on a gauge.

The relation described by Otis between the size of the penis and that of the urethra only holds good in a limited number of cases; and a stricture dilated to No. 21 may be cured in one person, while in another No. 32 is not too large.

The meatus varies from a mere pinhole to the size of No. 30 mm. F.; very often it is the narrowest part, and it never dilates readily. The fossa navicularis, on the other hand, is fairly wide, and can be enlarged without difficulty. After this the canal is narrow again, the diameter slowly increasing as the bulb is approached; but the mucous membrane is so abundant and the tissues around so soft, that in most cases No. 30 F. and even No. 34 F. will pass with very little pressure and without any hemorrhage. At the membranous part again there is a very sudden constriction; but here the structures around the canal are so rigid and unyielding that it can rarely be dilated beyond No. 12, or at the utmost No. 13 E.; and very often instruments of this size only pass with considerable pain. After this in the prostatic portion the distensibility increases to such an extent that the forefinger (if an opening is made in the perineum) can be passed through it without difficulty, and without lacerating the mucous membrane.

There are certain consequences which not uncommonly follow the introduction of a bougie or catheter; and, so far at least as most of them are concerned, the liability to their occurrence is distinctly greater when a stricture is present, especially if it is recent and the mucous membrane is soft, hyperæmic, and over-sensitive. In old cases, or where a catheter has been repeatedly passed, it may be conjectured that the nerve-endings have to a great extent lost their sensibility.

Most of these have been already mentioned; some are due to mechanical violence (hemorrhages and false passages, for example); others to inflammation, affecting the urethra, bladder, or prostate; and others again to the influence upon the nerve-centres. Of these the most important are atony of the bladder muscle, leading to retention; paralysis of the vasomotor nerves of the kidney, causing

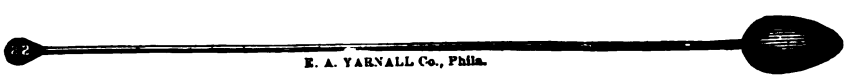



FIG. 478.—Bulbous Sound for Diagnosis.

hæmaturia, or suppression, syncope, shock, rigors and urethral fever in its various forms.

The same precautions should be used in exploring the urethra with a sound as in passing a catheter. The patient should be prepared in the same way and the same method adopted; but as the object is not to get into the bladder with the least friction, but to ascertain what sources of friction there are in the urethra, anæsthetics and cocaine are not advisable.

*Method of Exploration.*—As a rule it is best to commence with a sound of moderate size, No. 15 or 17 F.; if this passes smoothly and easily along the mucous membrane, stretching out the folds without meeting with any resistance, a larger one, No. 20 or 21 F., may be tried; and if this is equally successful, it may be concluded that there is no serious degree of contraction.

More frequently the instrument is grasped and held as soon as the point passes the fossa navicularis. The unstriped muscular fibre slowly contracts upon it, holds it fast for a minute or two, and then gradually tires itself out and releases it again. For this reason bulbous sounds with a comparatively slender shaft are more useful for exploring than those of which the diameter is the same throughout; with the former the enlargement only is held, and the degree of resistance in different parts of the canal can be appreciated; with the latter the shaft is grasped with as much tenacity as the end, and the delicacy of touch is to a great extent lost.

This occurs even when the urethra is perfectly healthy, especially if a catheter is being passed for the first time, or if the patient suffers from gout or from highly acid urine; the instrument is firmly grasped the whole way down. Very often a second sound several sizes longer can be passed more easily than the first. If however, before the membranous part is reached, there is one spot more sensitive than the rest, or if, after passing easily for an inch or two, the sound is suddenly

arrested and held for a time, and perhaps is stopped again a little further on (especially at the bulb, for the muscular coat is thickest there), there is probably some local affection, not sufficient of itself to cause distinct narrowing of the canal, but quite enough to render it tender and sensitive when touched, and to make the muscular fibre of the deeper part of the urethra involuntarily contract upon the offending body and bar its further progress. In the bulbous part this is not unusual; and if the front portion of the urethra is not examined with sufficient care the mistake may be made of imagining that there is an organic stricture deep down, while the real cause is some superficial lesion, a mass of granulations, perhaps, or a little inflammatory thickening near the orifice. Examination with the endoscope under an anæsthetic usually reveals at once the true state of things; unlike an organic or true stricture, the obstruction disappears completely as the mucous membrane becomes insensitive, even with cocaine; the largest tube then that the meatus will admit can be inserted without the least pain, and an accurate diagnosis made, both as to the seat and the nature of the lesion.

When there is a definite organic stricture the sound is either stopped abruptly, or, if the spasmodic contraction relapses sufficiently to allow it to pass, the surface feels rough and irregular. The situation of the stricture, its size and length, and whether it is the only one present, must next be ascertained. Smaller sounds must be used for this, until one will pass; but now, as the object is not to ascertain the presence of a stricture, but to find out how wide it is, flexible instruments, which will find the easiest path for themselves, are better than rigid ones. The length can only be ascertained by passing through the stricture a sound with the shaft graduated with inches, and a conical bulb at the end; as this is drawn out, the base of the cone catches against the edge of the stricture and makes the furthest limit. Great care, however, is necessary for this. Recent strictures are easily displaced, owing to the looseness of the submucous tissue; and if the shaft of the sound is too flexible, or if it is not held in the axis of the canal, it is easy to manufacture a stricture at any point; as the bulb is withdrawn, it throws the mucous membrane of the urethra into little transverse wrinkles, over which it slips with almost the same sensation as over a definite fibrous ring. Deeper strictures, of course, can only be found out when they are narrower than the superficial ones.

**Treatment.**—The object in treating stricture is not merely to dilate that portion of the urethra to its full dimensions, but to prevent it narrowing again. The first is usually easy; the second exceedingly difficult, as the lymph thrown out resembles scar tissue in its tendency to contract; but as cicatrices differ in this respect, according to their cause, those due to burns being the worst, so it is claimed for some of the methods used that they either insert in the stricture, as it were, a splice of material less prone to contract, or even cause the disappearance of the cicatricial tissue itself.

*General.*—The first thing in all cases is to allay as far as possible the spasm and congestion, that are nearly always present. In cartilaginous strictures, it is true, they are not of so much importance; but in recent cases, of only a year or two's duration, they are not unfrequently the main obstruction. It is a very common thing to find that a stricture which at first appears almost impassable, after a few days' rest in bed under proper treatment, allows a No. 9, or even a No. 10, to slip through with ease.

When the attack is recent and acute, accompanied by retention of urine, this demands the first consideration. Either a catheter must be passed at once, or the patient must be placed in a hot bath, the bowels opened as soon as possible, and, if the condition of the kidneys is such as to allow it, a full dose of opium given. Where the case is not so urgent, a great deal may be done by attention to general treatment: the diet should be light and unstimulating; the bowels kept well open; and if the urine is very acid, or if there is a large amount of urates, the liver should be made to act thoroughly. Alkalies and hyoscyamus are of the greatest use; opium, if required, should be given in the form of a suppository. No stimulants should be allowed; the patient should have a warm bath every night; and, if he

is not kept in bed or confined to his room, care should be taken that his clothing is warm, and that he is not in any way exposed to cold.

Irritability of the urethra and spasmodic obstruction, provided there is no organic change, usually disappear in a very short time, and a catheter slips in readily and without pain. If the spasm persists, the urethra may be stretched every second or third day by passing a full-sized bougie as far as the bulb, and leaving it until it is no longer grasped. At first the disturbance is often a little increased, but, provided there is nothing local to keep up the spasm, this rarely fails. If it does, the endoscope usually reveals some cause, such as a small mass of granulations, or a slight roughness of the mucous membrane in the anterior part of the urethra, which will not get well without local treatment.

**Local.**—There are five chief methods of treating stricture—dilatation, rupture, incision, excision, and electrolysis. Of these, the first three are the most important, and each of them is capable of being carried out in various different ways.

1. *Dilatation.*—This may be either interrupted or continuous. In the former instruments are passed every two or three days, but are not left in; they are simply introduced and withdrawn again; three or four sizes may be passed at each sitting, but none should be so large as to be tightly grasped by the stricture; and each time it is as well to commence, not with the largest used on the previous occasion, but with one a size smaller. In the latter an instrument is passed and left in, so that the end only lies just at the neck of the bladder. The principle in the two is somewhat different; the former relies merely on mechanical means; in the latter the instrument sets up a certain amount of irritation, which must have some effect upon the stricture tissue, for the dilatation succeeds as well with a small sound as with a large one. Indeed, if the instrument fits the stricture tightly, it is very likely to set up so great a disturbance as to require the treatment to be stopped for a time.

(*a*) *Interrupted Dilatation.*—The instruments used for this purpose may be either catheters or bougies: the former have the advantage of allowing a drop of urine to flow away, and of showing that the bladder has been successfully reached; but against this there is the serious objection that, especially in the case of the smaller ones, they are more inclined to break, owing to the eye, and also that it is not so easy to ensure absolute cleanliness. Soft ones should always be preferred to rigid: if the stricture is of wide calibre, they pass just as well; if it is small, they find their way; if they are properly made, infinitely better. A small metal instrument may be guided by the hand more easily, it is true; but the point is as sharp as a needle, and unless it is held with the lightest touch, it is sure to perforate the mucous membrane, and either make a false passage or else convert an annular stricture into a bridle.

The bougies in common use are of various kinds. The English or gum-elastic are made of woven silk, coated with copal varnish, so that they retain, to some extent, when cold, the shape given them when heated. These are of the same circumference the whole way down. The French or black bougies are made of the same material, but are much more flexible and of different shape. Some little distance from the point the instrument tapers gradually until it becomes exceedingly pliant; the point itself is either left unguarded, or, in the olivary bougies, is expanded into a small bulb supported upon a slender neck. Genuine French bougies are as flexible as india-rubber tubing, and if the bulb touches anything the neck bends at once. English black ones are stiffer, the neck especially is not so pliant, the bulb is usually too large, and, as soon as any pressure is made upon it, instead of the curve being limited to the neck, it involves a fourth of the length. The smaller sizes must be carefully examined to see that the varnish is not cracked at the neck; there is not so much danger as in the case of catheters, but it is not uncommon for the bulb to break off suddenly, and this might easily happen in the urethra with very serious results. Sometimes the shaft is made rigid by weaving it round a metal stylet, so that the instrument can be bent to any shape. For very

narrow strictures bougies are made of whalebone, catgut, or silkworm gut. The first-named is too rigid, even when softened in boiling water, to be of much service. Catgut is more useful, but it soon grows soft in the urethra, and then bends upon itself. Silk-worm gut is employed where bougies of moderate length and great tenuity are required. Some of these should be straight; others bent or twisted a little at the point, so that, if the orifice is not found at once, the whole face of the stricture may be explored systematically, one part after the other, by merely twisting the instrument between the finger and thumb.

Besides these, there are many contrivances for special occasions or for very narrow and tortuous strictures. Harrison's whip-like bougies are about two feet long, very thin, and tapering to a fine point at the end. If this slips through the stricture, the thicker part will follow, and coil up in the bladder out of the way. Then it may either be left in to dilate the stricture, the urine passing by the side of it, or it may be used as a guide or pilot for a railroad or tunneled catheter (*i.e.*, one with an opening at the end instead of the side), or for the hollow staff of a Maisonneuve-Teevan urethrotome. Sometimes, a silver tube, open at both ends, is of help; it should be about six inches long, and as large as the meatus will admit. This may be passed down to the face of the stricture, and then filled with a number of filiform bougies; if these are tried, one after the other, occasionally one will slip in. An instrument, known as a pathfinder, is further elaborated from this: it consists of a straight tube (20 mm. F. in diameter), the end of which is closed by a disc which can be made to revolve. In the disc is a small perforation, through which a filiform bougie passes, and, as the disc rotates, this is carried successively all round the stricture, until at length the orifice is found. The endoscope answers better still: if the opening of the stricture can once be seen, a fine-pointed bougie can often be guided into it without difficulty.

A stricture should never be condemned as impermeable, so long as a drop of urine comes out from the meatus; by trying one kind of bougie after another, by carefully and systematically exploring the face of the obstruction, the orifice can be found in nearly every case. Cocaine is of great value; a few drops of a ten per cent. solution injected into the urethra render it insensitive, and do away to a great extent with the muscular spasm; but, of course, care must be taken not to injure the mucous membrane. An anæsthetic is rarely necessary. Sometimes 4 c.c. of oil may be injected into the urethra with benefit; occasionally the little granulation or fold of mucous membrane, which often covers in the orifice, and prevents the bougie entering, can be floated off in this way; and, in some instances, where nothing else succeeds, a bougie can be passed during the act of micturition.

False passages give most trouble; they nearly always start from the floor of the urethra, and, though they are most common in the region of the bulb, they may occur in any part. As a rule, a slight check is felt at the moment the point of the instrument slips to one side, and, if this is carefully noted, it may be avoided afterward. The patient very often feels it as well, and sometimes is able to give valuable information. When there are several, or when flexible bougies persist in following the wrong track, metal instruments may succeed, the point being guided by the finger in the rectum. Sometimes, if the opening in the mucous membrane is occupied by one instrument, a second may be passed by the side of it in the right direction, but, when two or three of these passages start immediately in front of a stricture, the difficulty of avoiding them all is very great.

If there has been great difficulty in introducing a bougie, it may be tied in for a time, beginning with continuous dilatation. When this is not necessary, the bougie is withdrawn, being left only so long as the spasm continues, and a larger one is passed at once before the track is lost. Two or three sizes may be passed in this way every second or third day with the minimum of inconvenience; the best time is in the morning, an hour before the patient is allowed to get up. When the stricture admits No. 15 to 17 mm. F., the intervals may be prolonged, but the dilatation should be continued until no obstruction can be felt with a full-sized bullet-sound. Even after this, a catheter must be passed occasionally—once a

week at first, then once a month, and after a time perhaps at longer periods still, to ensure that there is no recontraction. Unless the stricture is a very recent one, so that the greater part of the infiltration is still cellular, permanent cure is not to be expected.

The dilatation can be effected much more quickly by the use of conical or bellied sounds. The best are Lister's, made of plated steel, so as to combine weight with perfect smoothness of surface. The ends are enlarged a little; behind the neck they increase gradually in thickness until, at the other end of the curve, they are about three sizes (English) larger than the point. With these the strictured tissue may be rapidly stretched to almost any size, and without tearing the mucous membrane. Many patients, however, resent the tension they cause, and there is the disadvantage that the point of the sound is no longer the only part of the instrument that touches the mucous membrane, and conveys sensations to the hand of the operator.

(*b*) *Continuous Dilatation.*—In this, as already mentioned, the instrument is left lying in the stricture for twenty-four or forty-eight hours, the patient being confined to bed, or, in exceptional cases, allowed to move about a little in his room. A longer time than this, without changing the instrument, is not advisable; and, owing to the irritation that is set up, it is usually as well to allow an interval of two or three days before the next is introduced. Even then, there is usually a muco-purulent discharge from the urethra.

The instrument should never be so large as to fill the stricture; a small one acts just as well as a large one, and is much less likely to cause nervous symptoms, and it should be tied in so that the point lies just in front of the neck of the bladder. Either a bougie or a catheter may be used; if the former, the urine comes by the side; if the latter, the instrument may be pushed into the bladder every now and then, and withdrawn again. In this way a stricture, through which No. 3 F. can scarcely pass, will admit a No. 10, and even a No. 11 easily, after forty-eight hours. The presence of the foreign body sets up a certain degree of hyperæmia; the fibrous tissues become soft and swollen; all the meshes are filled with fluid, and the denseness of the cicatrix disappears for a time. Unhappily, if left to itself, without instruments being passed at frequent intervals, contraction sets in even sooner than when the stricture is treated in the intermittent manner.

*Merits of Dilatation.*—This method is most useful in recent strictures, in which the effusion of lymph is still more or less cellular, and has not yet spread beyond the mucous and submucous layers, or involved the periurethral tissues. Those near the meatus, and those in which a band of lymph passes across from wall to wall, can be treated much more satisfactorily in other ways. Dense, old cartilaginous strictures frequently will not dilate at all, the tissues are too hard; or, if they do, it is only up to a certain point, No. 10 or 11; then they stop and seem to be entirely unaffected by anything further. Sometimes, too, strictures recontract so rapidly that incision offers a better prospect, and, occasionally, instances are met with in which patients resent the passage of an instrument to such an extent that it is advisable to get rid of the structure at all hazards by one operation. It is not uncommon to find that though, so long as a stricture persists, every attempt at passing a catheter is followed by a rigor, almost anything may be done, and with impunity, as soon as the constriction is divided.

Continuous dilatation may be employed where there is a very small stricture and great difficulty in finding the orifice, but it is distinctly more liable to be followed by suppression of urine, acute nephritis, and other serious consequences, and relapses are more rapid. Further, it practically necessitates confinement to bed, but in many cases it is almost essential as a first step toward something else.

2. *Rupture.*—Many instruments have been devised for rapidly stretching or tearing through stricture tissue without dividing the mucous membrane. Thompson's is composed of two blades, which are passed into the urethra closed, and then very slowly separated to any required extent by means of a lever worked from the handle of the instrument. Holt's is shaped like a catheter divided into par-

allel halves except at the tip; between these there is a fine, central guiding rod (Fig. 479). Dilatation is effected by passing on this tubes of various size, so that, when they are forced down between the blades, these are driven asunder. In Berkeley Hill's, a wedge on the end of a slender shaft is used instead, so that there is much less friction, and the dilatation is limited to one part at a time.

The tissue of which a stricture is formed is quite inelastic, and it is claimed that by the use of these instruments it is either stretched to its utmost, or actually ruptured, without the mucous membrane being torn, though, of course, it is badly bruised. The process is exceedingly simple, but as a matter of fact the mucous membrane is always torn or crushed, and there is no guarantee that the force is applied to the right place: the weakest part, wherever it is, gives way first. Moreover, this method is peculiarly liable to be followed by the more severe forms of constitutional disturbance — rigors, urethral fever, and suppression of urine; and relapses occur more quickly than they do after gradual dilatation. Even when it is essential, for some reason, that the stricture should be dilated at once, some form of urethrotomy, where what is done can be felt and regulated at the time, is to be preferred.

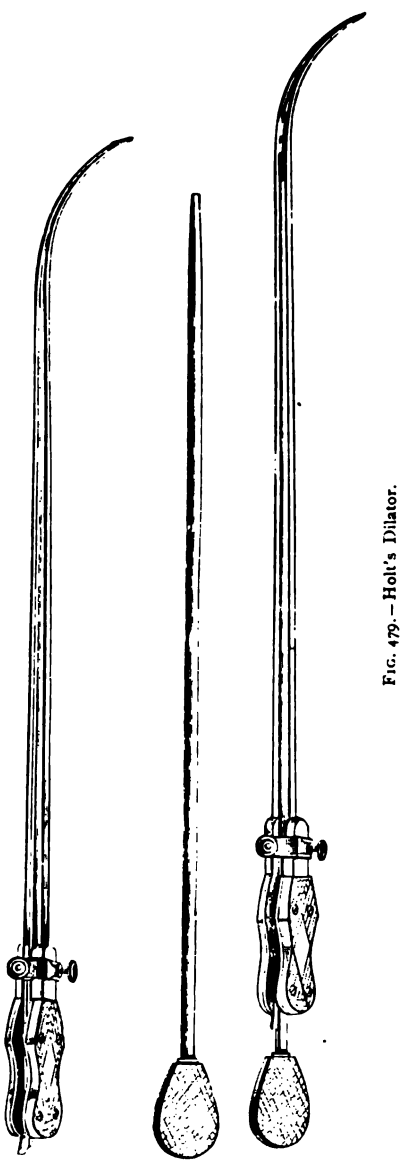


FIG. 479.—Holt's Dilator.

3. *Urethrotomy.*—(*a*) *Internal*, incising the stricture from the urethra. This may be done in two ways, either from in front, cutting backward toward the bladder, or from behind. In either place something must be passed through the stricture first: in the former to act as a guide for the blade of the urethrotome; in the latter to dilate the narrowed part sufficiently to allow the instrument to pass through. Whichever plan is adopted, it is essential that the stricture should be fixed in some way, and that it should be divided through its whole length and depth. Serious hemorrhage does not occur so long as the incision is limited to the proper structures. The incision is generally made along the floor of the urethra: if Civiale's instrument is used, this is necessary, as the main guide as to the depth of the cut is the sensation conveyed to the finger placed on the skin over the stricture: with the others it is not essential, and the incision may be made at the sides if required. Owing to the presence of large veins, the roof of the urethra is better avoided, so far at least as the penile part of the urethra is concerned.

Division from behind is scarcely possible unless the stricture will admit a No. 10, or at least a No. 9; so that if this plan is followed it must in a large number of cases be preceded by dilatation. There are two methods in which it may be accomplished. In Civiale's instrument the end of the shaft is dilated into a

bulb, concealing a fine cutting blade; by means of a screw in the handle this can be protruded to the extent required (Fig. 480). The bulb is passed through the stricture with the blade sheathed: the penis is drawn up as far as possible so as to fix the part that is to be divided, and the screw turned. The forefinger of the other hand is pressed firmly on the skin over the stricture, and the knife is drawn through, cutting deeper and deeper, until all the tough fibrous bands which grate like so much tendon against the edge are thoroughly divided. Then the knife is sheathed again and the instrument withdrawn. In Otis's, on the other hand, the stricture is fixed and stretched until it is quite tight by gradually separating the two parallel rods; then the knife is protruded as far as is thought advisable and drawn quickly across the tightened bands (Fig. 481). If the division is not complete the side rods are screwed apart again and a fresh incision made.

In the anterior part of the urethra these succeed equally well; the one be-

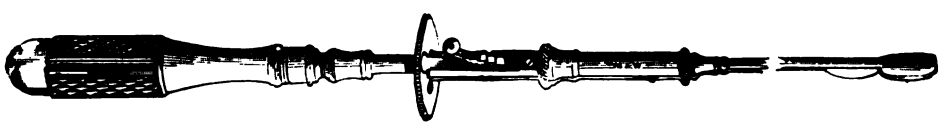


FIG. 480.—Civiale's Urethrotome.

cause the strictured part can be held firmly with the fingers, and every fibre felt as it is divided; the other because the touch of the instrument is so light when it is but a short way down the canal. In the deeper part, especially near the bulb, Civiale's is the most convenient.

A stricture that is too small to admit these may be divided from in front by means of Maisonneuve's urethrotome, as modified by Teevan and Berkeley Hill (Fig. 482). A filiform bougie must first be passed, and on this an exceedingly fine catheter, so as to make sure that the end is really in the bladder, not coiled up in some false passage. The catheter may then be withdrawn and the guide that screws on to the end of the urethrotome passed instead. The instrument itself consists of two parallel rods, together only equal to a No. 7 F., joined at the tip, but allowing a wedge on the end of the shaft to slide down between them as far as the curve. The knife is concealed in the wedge, and is not protruded until this

FIG. 481.—Otis's Urethrotome.

has been passed as far as it will go; in this way the wall of the urethra and the stricture are firmly held; and the wedge being pushed forward bit by bit, as the tissue is divided with the knife, the whole length may be cut through without endangering anything else.

The success of this operation depends very greatly upon the after-treatment; if urine becomes infiltrated into the wound, suppuration is sure to occur, leaving behind it a cicatrix which reproduces the stricture in a still worse form; and there is very great danger of other troubles—rigors, urethral fever, abscesses, and even pyæmia. A full-sized bullet-sound, No. 24 or 26, must be passed to make sure that the stricture is thoroughly divided; the urine that remains in the bladder drawn off; and the cavity washed out with boracic acid or a very dilute solution of corrosive sublimate. No catheter should be tied in unless there is profuse and continuous hemorrhage. A morphia suppository (if the kidneys are fairly sound) may be placed in the rectum, and then the patient must be removed to bed, and en-

joined to delay micturition as long as possible, in order that the surface of the wound may be sealed with lymph before urine is allowed to flow over it. When the bladder must be emptied, which is often not for six or seven hours, a large cup of tea should be given, with five grains of quinine and half an ounce of brandy, and the patient placed in a hot bath, so that the flow of urine may be as free as possible, and without any straining. If this plan is adopted there is rarely any fever after the operation; sometimes a rigor occurs after micturition: within a few minutes the temperature begins to rise, the patient feels chilly and begins to shiver, there is a feeling of the most intense distress: the thermometer reaches 104° F. and even higher; then after twenty minutes or half an hour it begins to fall and profuse sweating sets in; but this is seldom of any import. In any case the patient's temperature should be carefully taken after micturition, and if there is a sensible rise it should be met at once by repeating the quinine. No instrument should be passed for at least a week; the patient must be kept in bed, on light diet and without stimulants; the bowels may be opened on the third day, and a warm bath taken every night. At the end of a week a No. 22 bullet sound may be carefully passed down the urethra and withdrawn again; if the operation has been successful, no hitch should be felt anywhere and there should be no stain of blood. Three days later another may be passed, and then the patient may be instructed how to make use of one for himself.

Internal urethrotomy is employed by some to a very much greater extent than by others, but there are certain cases in which it is generally preferred.

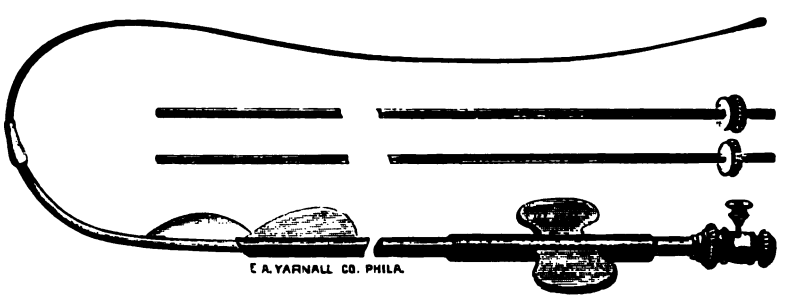



FIG. 482.—Teevan's Urethrotome.

1. Strictures near the meatus, especially those at the orifice itself; these may often be divided with an ordinary bistoury.

2. Strictures which re-contract rapidly after dilatation.

3. Strictures in patients who suffer severely from rigors or other troubles whenever a catheter is passed. In such cases it is best to finish the operation at a single sitting, and it is often found that the irritability of the urethra disappears altogether as soon as the stricture is divided.

4. If there is a perineal abscess present, and the stricture is divided before the mucous membrane has given way, a fistula may sometimes be avoided.

Dense cartilaginous strictures that refuse to dilate may be treated in this way, but they frequently require more than one operation, and for them external urethrotomy is certainly to be preferred.

In recent strictures, or where there is advanced disease of the kidneys, or where the urethra is inflamed, a cutting operation is not advisable. In advanced cases of cystitis, where the urine is ammoniacal and loaded with mucus, the stricture may be divided and an opening made in the perineum to drain the bladder and to prevent decomposing urine flowing over the surface of the wound.

**Complications.**—Internal urethrotomy is liable to be followed by the same complications as simple catheterism, but some are more common and more serious than others. Rigors have been already mentioned. Hemorrhage (either at the time of the operation or later, especially at night, if there is an erection) is some-

times very profuse. In the penile part it may be controlled by passing a large gum-elastic catheter down the urethra, and compressing the bleeding point against it with a bandage, until a coagulum has formed; or an ice bag may be laid upon it; when it is at the bulb a well-padded firm crutch, after Otis's plan, answers best.

If there is evidence of infiltration of urine at the seat of operation, a staff should be passed down the urethra and a free incision made from the outside. Abscesses should be opened as soon as possible; but if they occur in connection with the prostate they usually make their way into the urethra. Acute epididymitis is not uncommon, especially if the urethra is explored too soon and too much after the operation; and, particularly if the kidneys are diseased, partial or complete suppression of urine may occur, though the liability to this occurrence may be greatly lessened by taking proper precautions.

*Subcutaneous Urethrotomy.*—In the penile portion of the urethra short strictures may be divided from the outside by means of a long, narrow tenotomy knife. A staff is passed down the urethra, the stricture fixed with the fingers, and the knife thrust through the skin, making a minute puncture, and carried along the staff until all the resisting portion of the stricture has been divided. It is then withdrawn, and the puncture sealed. The after treatment should be the same as in internal urethrotomy.

(*b*) *External urethrotomy*, where an incision is made from the outside into the urethra, passing through the whole of the stricture tissue.

There are two distinct classes of cases in which this may be required. In the first a catheter can be passed through the stricture; in the second it cannot, either because the urethra has been destroyed by extensive sloughing, or because

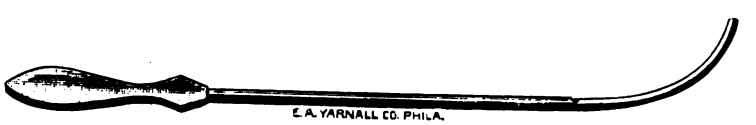



FIG. 483.—Syme's Staff.

it is so tortuous that, though urine can find its way out, it is impossible to worm a bougie through it.

*Syme's operation*, external urethrotomy in the strict sense of the term, where an instrument can be passed into the bladder. Syme's staff consists of two parts of different diameters; for the last two inches and a half, it is about the size of No. 6, and this is grooved on the convexity; the rest of the instrument is equal to a No. 18 or 19. The junction of the two is abrupt, so that there is a sharply marked shoulder, which is intended to rest upon the face of the stricture; the groove is continued on to this, but no further. This is passed into the bladder, the finger being placed in the rectum, to make sure that it has not entered a false passage, and given to an assistant to hold. The patient is then tied up in the lithotomy position, and the assistant directed to push the convexity of the staff downward toward the perineum. The left forefinger is placed in the rectum, and an incision made exactly in the middle line, about an inch in front of the anus, and carefully carried down until the groove in the narrow portion of the staff is reached; this is usually behind the stricture. The knife is carried forward, cutting from the anus, in the groove of the staff, right through the stricture as far as the shoulder. A probe-pointed narrow gorget is introduced through the wound into the groove, and pushed on until it enters the bladder; the staff is withdrawn, and a full-sized catheter passed from the urethra along the gorget, using it as a director. Generally the catheter is tied in for the next three days, and then withdrawn; but I have not found this necessary. If the stricture is divided thoroughly, the wound may be left entirely to itself, the patient being kept in bed, and treated in the same way as after the operation of internal urethrotomy. At the end of a week a full-sized bullet sound may be passed, following the roof of the urethra, a few drops of a ten per cent. solution of cocaine being injected into

the wound to prevent pain; and this may be repeated, at first every second day, and then gradually at longer and longer intervals.

This operation is especially useful in dense cartilaginous strictures complicated with fistula, where internal urethrotomy has no chance of succeeding; and it may be performed with very great benefit in advanced stricture deep in the urethra, where the bladder is diseased, the urine ammoniacal, and the kidneys affected. In this case, however, a drainage tube should be passed through the wound into the bladder, and connected with a receiver outside the bed. Of course, the prognosis in such cases is not good, but it relieves the bladder at once, the urine gradually becomes clear and acid, the amount of mucus diminishes, the con-

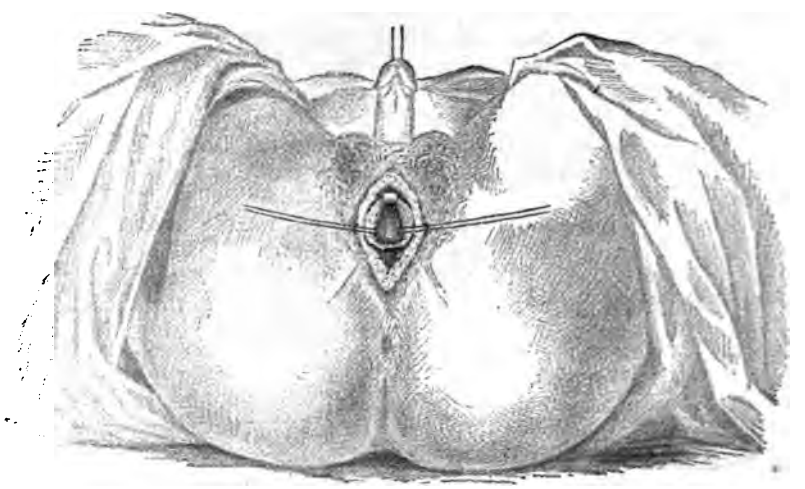


FIG. 484.—Wheelhouse's Operation, showing the Sides of the Urethra held apart by temporary Sutures, and the Apex of the Triangle stretched up by the Button on the end of the Staff.

stant desire to micturate ceases, the patient enjoys such rest as he has not had for years, and very often the general health begins to improve at once.

There is another advantage claimed for this operation, that it holds out a prospect of permanent cure. There is no doubt that sometimes, if external urethrotomy is performed in cases of rupture of the urethra before extravasation of urine has taken place, the formation of a stricture can be prevented, but Harrison has described cases in which a dense cartilaginous stricture has apparently completely disappeared. In 1867 Bickersteth performed Syme's operation for traumatic stricture and urinary fistula of the worst type; in 1869 the man was known

FIG. 485.—Grooved Staff, with Button-like End.

to be quite well, though no precautions appear to have been taken by the patient. After his death, in 1885, the urethra was removed and carefully examined, and no signs of the stricture could be found; in fact, the urethra is described as being of larger calibre in proportion to the rest of the canal, opposite the line of section, as if the cicatrix had yielded to the pressure of the urine. I have myself the notes of a patient on whom external urethrotomy was performed eighteen years before he came under my care, and though he assures me that he has not taken the slightest precaution since, there is no evidence of any recontraction.

When a catheter cannot be introduced into the bladder, either the urethra should be laid open in front of the stricture, so that the face of it may be seen

(Wheelhouse's operation), or an incision is made into the urethra behind, through the perineum, and prolonged forward through the stricture tissue until the canal is reached again in front (Guthrie's perineal section, or Cock's operation).

*Wheelhouse's Operation.*—The patient is placed in the lithotomy position and a special staff passed down as far as the stricture. This instrument is straight, with on one side a groove, which runs down until within half an inch of the point, and on the other, at the point itself, a projection in the form of a blunt hook. An incision is made on to the staff so as to open the urethra a quarter of an inch in front of the stricture, and two sutures are looped through the edges of the mucous membrane, so that the sides can be held apart by assistants. The staff is withdrawn until the end appears in the wound, and turned round so that the pro-

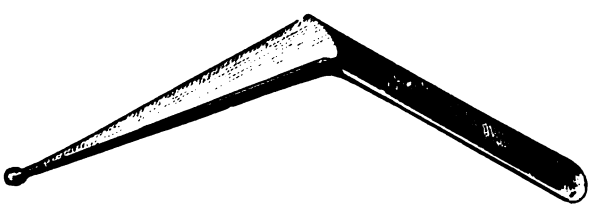


FIG. 486.—Teale's Probe-gorget.

jection is hooked into the upper angle of the opening in the urethra. This is stretched in this way into the shape of a triangle, the base of which is formed by the front of the stricture. There is very little hemorrhage, and nearly always the orifice can be seen at once. A probe is then carefully passed through the stricture, and the whole length is carefully and deliberately divided along its under surface. The subsequent proceedings and the after-treatment are the same as in Syme's operation, a probe-pointed narrow gorget being used to pass into the bladder through the wound and act as a guide for the catheter.

*Perineal Section.*—The patient is directed to hold his urine if possible for some hours before the operation, so that the neck of the bladder and the proximal part of the urethra may be distended. The position is the same, and the surgeon begins by passing his left forefinger into the rectum to draw it back, and to feel the apex of the prostate. An incision is then made exactly in the middle line of the perineum an inch and a half in length and half an inch in front of the anus, and it is gradually deepened, until, if the patient strain or cough, the urethra bulges into the wound. If this does not happen, the point of the knife, guided by the finger in the rectum, must be pushed forward so as to hit off the membranous portion of the urethra or the apex of the prostate. If urine escapes through the puncture, difficulty is at an end. A director is then passed into the bladder, and along this a narrow probe-pointed gorget. The stricture may either be dealt with at once (the other end is easily found by passing an instrument down the urethra) or the bladder may simply be allowed to drain itself for some days. It is not uncommon to find that a stricture which obstinately resists all attempts before the operation can be easily passed afterward, and either dilated or divided.

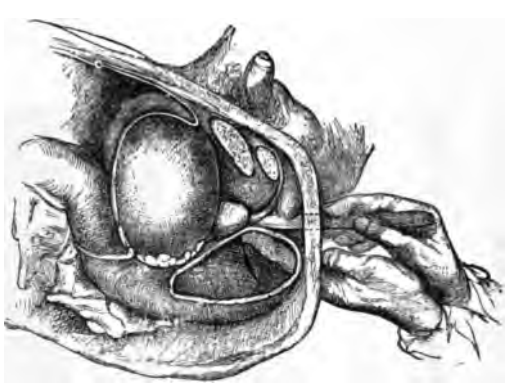


FIG. 487.—Cock's Operation for Tapping the Urethra at the Apex of the Prostate, or Perineal Section.

In cases in which a large portion of the urethra has been destroyed by sloughing, and it is doubtful whether it is possible to establish a new canal, or whether, if it is established, the patient will take the trouble to maintain its patency, an opening may be made into the bladder over the pubes, and fitted with an india-rubber tube and stopcock. With this arrangement patients may live and continue their ordinary occupation, not only with perfect safety, but almost without inconvenience.

4. *Excision.*—In exceptional cases strictures in the penile portion of the urethra have been excised, and the edges of the mucous membrane sutured together, and even strips of mucous membrane from other parts of the body have been spliced in. Such operations, however, can very rarely be required, as most strictures so placed are amenable to simpler treatment.

5. *Electrolysis.*—The treatment of stricture by electrolysis has recently been revived by Newman, Bruce-Clarke, Steavenson, and others. The negative electrode is passed down the urethra, and allowed to remain in contact with the face of the stricture for the space of some minutes to half an hour; the positive is applied to some other part of the patient's body, and a current of three to five milliampères used. In stricture near the meatus the gradual melting away of the cicatricial tissue under the influence of the caustic set free on the surface of the electrode, can be seen, and there is no doubt the same process takes place when the stricture is deeper; but in many patients it is attended with quite as much pain as gradual dilatation. There is usually a considerable degree of soreness and irritation afterward, and unless the same precautions are taken, there is no greater degree of immunity. It is true that in some instances recontraction does not occur for a considerable time; but in picked cases the same may be said of nearly every other method, and I have known it take place within six months.

## Extravasation of Urine.

Urine may escape from the ureter and pelvis of the kidney, from the bladder (entering the peritoneal cavity of the cellular tissue), or from the urethra. The last mentioned is by far the most common, and is generally understood by the term extravasation.

**Causes.**—The urine may come from the prostatic, membranous, or penile portions of the urethra. In the first case the causes (and the symptoms) are practically the same as those of extra-peritoneal rent of the bladder. It rarely occurs except as a result of fracture of the pelvis, or of operations, such as lateral lithotomy, when the lobe of the prostate has been too freely incised. In children, however, it sometimes happens from severe compression without fracture, owing to the elasticity of the bones of the pelvis. The urine escapes into the prevesical space (that which is bounded by the two lamellæ of the transversalis fascia, the one going to the pubes, the other along the urachus to the bladder), above the deep layer of the triangular ligament, or else directly into the pelvic cellular tissue, above the recto-vesical fascia.

Extravasation from the membranous or penile portion of the urethra is caused either by injury (rupture, impacted calculus, urethrotomy, etc.), or by stricture. The latter is by far the more common. It may be either sudden or gradual. In the former case the urethra becomes thinned and dilated behind the stricture, owing to the constant pressure upon it, until, some day, under the effort of micturition it suddenly gives way, and the urine pours out into the tissues. In the latter a small follicular abscess forms, and gradually extends, ulcerating through everything under the constant pressure of the septic and decomposing urine, until at length it works its way to the exterior, and the urine escapes through a fistula without having been widely spread in the cellular tissue. This is not nearly so severe a form as the other, at any rate so far as the immediate symptoms are concerned.

When the extravasation commences between the two layers of the triangular ligament, it naturally remains limited until one of them, usually the anterior, gives

way. If, on the other hand, it is superficial to this, under the deep layers of the superficial fascia, it spreads at once until it may actually reach the ensiform cartilage. Behind its progress is limited by the attachment of the fascia to the posterior margin of the triangular ligament; in the middle line it cannot extend further back than the centrum tendineum of the perineum; under cover of the rami of the ischium, it can reach as far as the tuberosity, but it never enters the ischio-rectal fossa. At the sides the fascia joins the periosteum, so that the urine cannot extend on to the thighs. Only in front is the passage free, and if it is driven with any force it rushes into the scrotum under the dartos, passes over the pubes, and covers the surface of the abdomen, as low as Poupart's ligament at the sides, and perhaps as high as the ensiform cartilage in the middle.

**Consequences.**—Wherever urine spreads it causes inflammation and gangrene. The cellular tissue sloughs wherever it comes; the skin perishes, and exposes intensely fœtid masses of dark-colored tissue, sodden with urine and pus; and even the penis, testes, and other structures may be destroyed when the planes of fascia which serve at first to limit the urine in certain directions, break down.

**Symptoms.**—Sudden extravasation of urine is unmistakable. There is a history of obstruction, of some difficulty in emptying the bladder, for weeks or months before, if due to stricture—for the first time if the urethra has been ruptured; then, of the obstruction having suddenly given way, and of the bladder having emptied itself with a feeling of intense relief, but without any urine being passed externally. In a few minutes a smarting sensation is felt in the perineum and scrotum; soon they begin to burn and throb; in a few hours they swell to more than double the size; the patient becomes anxious and feverish, and a condition of extreme prostration sets in.

By the next day, especially if the urine was already septic, the sloughing is well advanced. The perineum projects under the scrotum, reddened, tense, and hard; the scrotum itself is swollen out to an enormous size, and is glazed and shining, with a peculiar translucent appearance from the amount of œdema; and the skin over the abdomen is dusky, pitting on pressure, and in bad cases crackling from incipient putrefaction. If there is a gangrenous spot on the penis, the prognosis, as Brodie first showed, is almost hopeless. The fever may be high, but more frequently the temperature is only moderately raised; the patient lies in a state resembling that of typhoid; the pulse is small and quick, the respiration hurried and shallow, the tongue dry and brown; often there is muttering delirium; and the eyes are sunken, and the face pinched, with a look upon it that cannot be mistaken.

**Treatment.**—This admits of no delay: the patient must at once be placed in the lithotomy position, and a free incision made deep in the middle line of the perineum, until the main source is tapped. Then other incisions must be made all over the dusky area; in the penis they must be perfectly straight and longitudinal, or the subsequent cicatrization may lead to serious trouble; on the scrotum one on each side is usually sufficient, but it should extend thoroughly into the sodden cellular tissue; over the abdomen their direction should correspond with the vessels. In most cases it is sufficient to make them two or three inches long; as soon as the œdema subsides they shrink more than half; sometimes there is sharp hemorrhage from a cutaneous vessel, but this may always be stopped by pressure with dried lint. Any sloughs that are loose should be extracted at once, and as much of the putrid fluid as possible squeezed out of the openings.

The treatment of the bladder, and of the stricture (if there is one), next requires consideration. It is distinctly of advantage to drain the former thoroughly, not only because it prevents more urine being extravasated, but because itself is almost sure to be in a state of advanced cystitis, half full of an intensely offensive putrid fluid. This may be accomplished either by dilating the prostatic portion of the urethra with the finger, first introducing a probe-pointed gorget into the bladder as a guide, or, better, by passing in a full-sized soft rubber catheter, and con-

necting it with a receptacle under the bed. Whether the stricture should be touched or not depends upon the condition of the patient. In most instances it is better to leave it alone; if the patient recovers, a catheter can often be passed without any difficulty; owing to the prolonged rest, the spasm and congestion entirely disappear. When, however, the case is not a severe one, it is most expeditious to pass a staff down the urethra, and at once lay the whole stricture open, as in external urethrotomy.

Great care must be taken to keep the patient dry; all the discharges (and they are often profuse), must be soaked up with frequently charged pads of absorbent wool, or finely picked oakum. Warm hip-baths, containing small quantities of some antiseptic, are of great service, if the patient's health permits. Sloughs should be removed as soon as possible, and the strength sustained by nourishing diet, quinine, and stimulants. The temperature requires very careful watching, as, like all operations about the urinary organs, extravasation is liable to be followed by pyæmia. If the patient does not die from this, exhaustion or renal disease, the wounds granulate in a very short time, and the cicatrices left are always surprisingly small.

### Urinary Abscess.

Peri-urethral abscesses are not uncommon in the glands by the side of the frænum in acute gonorrhœa, and occasionally they are met with in other parts of the corpus spongiosum, but the perineum is by far the favorite locality. They may be divided into two classes, those which communicate with the urethra from the first, having commenced on the surface of the mucous membrane, and gradually involved deeper and deeper structures; and those which originate independently of it, and if they do communicate, only do so secondarily, the mucous membrane covering them becoming thinner and thinner until at last it gives way.

**Causes.**—1. *Gonorrhœa.*—Abscesses occasionally form in the corpus spongiosum, but (except in the glands) they are not often met with unless there is an old stricture, or unless it has been necessary to pass a catheter frequently. Sometimes they extend down from the mucous follicles, but they may originate independently, and, if the pus is let out in time, they may never communicate with the urethra at all.

Cowper's glands are sometimes affected in this way. There is a small, hard, exceedingly tender spot, not quite in the middle line, by the root of the scrotum. After a time it works its way through the triangular ligament, toward the skin, or toward the rectum, so that its origin is often not recognized.

2. *Injury.*—Rupture of the urethra, impacted calculus, the formation of a false passage, internal urethrotomy, and forcible splitting of strictures, are occasionally followed by perineal abscesses. Some of these are due to infiltration of urine; but when, for example, a stricture is ruptured without the mucous membrane being torn, or when suppuration occurs in consequence of a catheter having been tied into the urethra, it is probable that the communication, if it exists, is secondary.

3. *Stricture.*—This is by far the most common.

Usually the suppuration commences outside the urethra, in the thickness of the stricture tissue; sometimes, however, it spreads from the interior—the mucous membrane is thinned and driven into pouches, which often contain small quantities of decomposing urine; ulceration spreads from these into the mass of inflammatory exudation around, and the communication exists from the first.

Abscesses may, of course, occur in the perineum from other causes, the urethra not being concerned in any way. Suppuration, for example, may occur in connection with the rectum and work its way outward in front of the anus, and peri-prostatic abscesses sometimes point in the same situation.

**Symptoms.**—Urinary abscess, except when it is the result of gonorrhœa, is usually of slow formation. If it occurs in the glans, there is a small, hard mass on one or both sides of the frænum, exceedingly tender to the touch, and rapidly

coming to the surface. In the perineum it depends to a certain extent upon the situation. Usually it is in the middle line, unless it originates in inflammation of Cowper's glands; if it is in connection with the bulb, or the deeper part of the corpus spongiosum, it stands out to a certain extent from the fixed tissues beneath, and often runs forward with a hard, spur-like process in the median raphé of the scrotum. When it begins between the layers of the triangular ligament there is merely a hard, but exceedingly tender spot, scarcely raised above the level of the rest. Fluctuation cannot be felt unless the abscess is superficial.

The pain at the first is dull and throbbing, with a great sense of weight; the stream of urine (even without stricture) is reduced in size and force; complete retention may occur, especially when the suppuration is in connection with the fixed portion of the urethra; and sitting and walking are attended with great discomfort. Then, as the pus forms, the pain becomes more intense, and shoots down the thighs and into the groin; very often there is high fever, with perhaps a rigor; and constitutional symptoms of great severity may set in. If the abscess is allowed to break of itself, it may discharge into the urethra; there is a sense of intense relief; a certain amount of pus is washed down with the urine, and sometimes the cavity contracts and heals without any extravasation, and without an external opening. More often, especially if there is a stricture, the abscess bursts externally as well as internally, and though the channel contracts as soon as the tension is removed, urine escapes through the opening, and a fistula is formed.

**Treatment.**—Urinary abscess should be opened in all cases as soon as possible. It is no use waiting for fluctuation, the sheets of fasciæ are so dense that the pus, if left to itself, often burrows long distances before it reaches the surface, and if there is no internal opening, a timely external one may prevent its occurrence. Buckston-Browne has pointed out that in cases of stricture associated with perineal abscess, if internal urethrotomy is performed, and the abscess opened freely from the outside, a fistula may often be prevented. Care must be taken that the incision, if the abscess is in the perineum, is kept absolutely in the middle line.

## Urinary Fistula.

Fistulæ may occur in connection with the kidney, ureter, or bladder, after wounds or operations, and as a result of malignant disease. Sometimes they open directly on to the exterior; sometimes they communicate with other organs—the rectum, vagina, or even the small intestine. Recent ones, in which there has been no great loss of tissue, and which are not kept open by a permanent irritant, generally close of themselves if the natural channel is patent. Attention to drainage and position (the patient, for example, lying prone when there is an opening between the bladder and rectum), the free use of antiseptics and astringents, and the occasional application of caustics, such as the actual cautery, or nitrate of silver melted on a probe, are of material assistance. If, however, they are old, and the walls have degenerated into dense suppurating sinuses, the surface of which is very likely coated over with a layer of phosphates, or if there is any persistent irritant (the capsule, for example, of a scrofulous kidney drained through the loin), further and sometimes extensive operations are required. These, however, and vesico-vaginal fistulæ must be dealt with by themselves.

*Urethral Fistulæ.*—These differ in severity, and may be divided into three classes:—

1. Simple straight channels, of recent formation, opening directly on to the exterior, without much induration around.

2. Complicated fistulæ, sometimes very numerous (as many as fifty have been described), opening in all directions, over the penis, in the groin, in the ischio-rectal fossa—anywhere near, in fact, with pouches and sinuses in which urine collects and decomposes, and embedded in dense cicatricial tissue.

3. Fistulæ, very often in the penile part, in which, owing to extravasation of urine, phagedæna, or other causes, there has been great loss of tissue.

Urethral fistula, except in those rare cases in which portions of the penis are removed by injury, is always the result of inflammation, and therefore nearly always of stricture. Abscesses, however, leaving sinuses behind them, do occasionally occur from other causes, such as a rupture of the urethra, impacted calculus, or urethrotomy. It is not material whether the suppuration commences on the surface of the mucous membrane, in connection with an inflamed follicle or dilated pouch, or whether it originates independently of this, in the tissues around; in either case the urine finds its way out through an easier channel, and a fistula is formed. In the majority of instances it affords little or no relief to the stricture. If there is a very wide opening, or if, as in suprapubic puncture of the bladder, the sinus is fitted with a suitable instrument, so that there is free exit for the urine, the bladder, being relieved from all tension, may recover its normal condition—to a certain extent at least, and the ill effects of stricture is avoided; but, except in such cases as these, the orifice of the fistula soon contracts until it is no larger than a pinhole, fresh inflammation takes place around it, more abscesses form, each leaving a new fistula, and at length the whole perineum is converted into a dense mass of cicatricial tissue, riddled with openings in all directions.

**Treatment.**—The treatment of urinary fistula depends upon the cause. The first thing is to remove any foreign body that is present (a calculus, for example), and to see that the natural exit for the urine is unimpeded in any way.

If the fistula is recent, and dependent, as it usually is, upon stricture, it will nearly always contract and heal up as soon as the stricture is healed. Sometimes it helps to stimulate the walls by injecting tincture of iodine, or to touch up the deeper part of the sinus with the actual cautery, or with a probe upon which some nitrate of silver has been fused. If, in spite of this, it will not close, means must be taken to prevent any urine passing through. Occasionally it is sufficient to press firmly with the finger upon the external orifice during the act of micturition. More frequently it is necessary to draw the urine off with a soft catheter as often as may be required, so that no drop shall flow along the urethra. This must, of course, be done before each act of defecation, and if, in spite of these precautions, the least drop escapes, the urethra must at once be thoroughly washed out with a weak astringent. It is no use tying a catheter in the bladder (unless it is connected with some constantly acting exhausting apparatus to suck the urine out), some will always pass by the side, no matter what the size may be; and not unfrequently it is positively injurious, from the amount of irritation it creates.

If this does not succeed and the stricture is fully dilated, it is possible that the irritation is kept up by some outlying sinus which cannot drain. In such a case it is best to perform external urethrotomy at once, cutting through the whole of the dense tissue in which the fistula lies. If there are many openings, or if there is an old cartilaginous stricture to deal with, this is almost always necessary.

Where a considerable portion of the wall has been destroyed by sloughing, a plastic operation may have to be performed in order to close the opening. To secure union by the first intention, the bladder should be drained, either through the rectum, introducing a winged soft catheter, or through an opening in the perineum, according to the position of the fistula. Then the edges may be pared and brought together, or a flap of skin may be raised from some adjoining part, and sifted so as to cover in the orifice.

### The Female Urethra.

The urethra in women is so short, and the extent of surface so small in comparison with that of the male, that it is much less likely to become inflamed, and stricture and other consequences are more rare.

Acute inflammation, commencing with great severity, and attended with scalding and purulent discharge, is not infrequent as a result of gonorrhœal in-

fection of the vulva. Milder forms are occasionally met with as a consequence of cystitis, and a slight but very troublesome degree of irritation, with increased secretion of mucus, is not uncommon during pregnancy, in malposition of the uterus, and in other affections of the generative organs. As a rule, unless the cause is a persistent one, it subsides readily under the use of astringent injections, combined with hot baths and purgatives. Stricture, as a result of inflammation, is rare; but it may occur from chancres or other sores at the orifice, and from sloughing of part of the anterior wall of the vagina. It may be treated either by dilatation or incision; rigors have been known to occur, as in men, but very seldom.

The opposite condition, dilatation, is occasionally met with, and when it involves the upper third, and still more the whole length, there is the most distressing incontinence. It may result from long-continued or often-repeated displacement, or from mechanical stretching. The adult urethra admits the forefinger easily, and, as a rule, if the dilatation is effected rapidly, no ill result happens; but if it is often repeated, or if it is carried beyond this, as in extracting a calculus, it may become permanent. Sometimes the middle portion only is dilated into a pouch (urethrocele) felt in the anterior wall of the vagina, and this, acting as a receptacle for decomposing urine, keeps up the irritation. When there is incontinence, due to impaired power at the neck of the bladder, galvanism, tonics, strychnia, cold, and other measures must be employed to restore the tone of the muscle.

Urethral caruncle, a small vascular growth at the meatus, occurring more frequently in married women than in young unmarried girls, may give rise to the greatest distress. It bleeds with the least touch, and causes the most intense suffering during micturition or when the parts are moved; at the same time there is usually great irritability of the bladder and a profuse discharge of mucus. The symptoms cease at once on its removal.

Fissure at the neck of the bladder is also occasionally met with, but it can only be diagnosed with the endoscope. There is a small superficial erosion of the mucous membrane, circular when the sphincter is stretched but appearing like a fissure as soon as it contracts. It gives rise to constant tenesmus and staining, with an intense burning pain at the end of micturition, and occasionally a few drops of blood. It may readily be cured by means of a light application of caustic, or by mechanically dilating the sphincter, so as to give the surface rest. The former method is preferable, as it is not always possible to graduate the effects of the latter sufficiently in individual cases.

# CHAPTER XXIV.

## *INJURIES AND DISEASES OF THE MALE ORGANS.*

### MALFORMATION AND DISEASES OF THE PENIS.

The roof may be defective (epispadias); or the floor (hypospadias); or the invagination that forms the fossa navicularis may fail to meet the part behind; if in this case there is no other defect, the urethra is imperforate, the kidneys become cystic, and the child dies at or before birth. Usually, however, there is hypospadias, and occasionally the two channels run one above the other for a considerable distance.

*Hypospadias.*—The orifice is usually at the base of the glans, or a little further back; the frænum is wanting; the prepuce forms a great fold on the dorsum like a cowl, and the corpus spongiosum possesses scarcely any erectile tissue. In other cases it lies at the end of the membranous urethra, the bulb and the scrotum failing to unite in the middle line, and forming labia, as in the female. When the defect is slight, the fossa navicularis may run back and end blindly; in other cases the penis is small, and the corpus spongiosum (if it is developed) incapable of erection.

*Epispadias.*—The complete form is always associated with ectopia vesicæ; occasionally the urethra opens behind the corona, the rest of the penis being well developed.

The treatment is not very promising. If the defect is slight, and micturition not impeded, it is better not to interfere. The orifice should be dilated to prevent any strain upon the structures behind; and if the urethra fails in front, so that it is impossible to direct the stream, an attempt should be made to carry it forward by means of a plastic operation. The flap must be double, so that a cutaneous surface may face the new channel; the deeper layer is taken from the side of the penis near, and twisted round upon itself; the superficial one borrowed from the redundant prepuce, the centre of the cowl being dissected up, and the glans thrust through the opening so that the dorsal surface becomes inferior, or *vice versa*, as the case may be.

*Phimosis* may be congenital or acquired, following balanitis, soft sores, chancre, or injury. In the former case the glans is often adherent, and the orifice may be reduced to the size of a pinhole, so that the prepuce swells out with each act of micturition. Circumcision should always be performed, unless the corona can be thoroughly and easily exposed; the secretion collects inside; there is a constant risk of balanitis and paraphimosis; preputial calculi may form; and the liability to syphilis and phagedæna is much greater. If gonorrhœa occurs, it is more severe; and the constant irritation undoubtedly favors carcinoma.

*Circumcision.*—The prepuce is drawn well forward, and clipped with a pair of polypus forceps in front of the glans; the projecting end cut off; the cutaneous sheath allowed to retract; and the mucous membrane slit up along the dorsum as far as its attachment. Each half is then cut away, following the line of the corona, and leaving the frænum and just enough to hold a few sutures. If catgut is used, and the wound dried and covered with iodoform, the dressing may remain on until the skin has united.

*Paraphimosis* is the condition produced by forcing the glans through the orifice of the prepuce when it is too narrow to admit it. The immediate result is congestion and inflammation, ending, if left, in ulceration and sloughing. The glans becomes swollen; the prepuce overhangs it like an œdematous collar, and

concealed behind this is a tight, unyielding ring formed by the orifice. In early cases reduction can usually be effected by oiling the parts well, and drawing the foreskin forward with the index and middle fingers of the two hands, while the thumbs compress the glans; or the penis may be wrapped round with lint, and gently squeezed in the hand until the œdema disappears; but in cases that have already lasted some days, it is often necessary to slip the end of a director under the constricting band on the dorsum, and divide it with a bistoury.

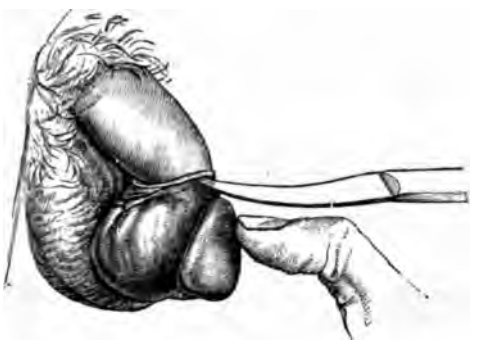


FIG. 488.—Mode of Dividing Prepuce in Paraphimosis.

### EPITHELIOMA OF THE PENIS.

Squamous epithelioma is not uncommon after middle life, commencing on the glans or the inner surface of the prepuce, especially in cases of phimosis. It usually begins as a warty nodule, which soon breaks down into an ulcer, with intensely hard base and edges. If left, the growth spreads rapidly, owing to the constant irritation of the urine; the corpora cavernosa and the glans are quickly infiltrated; the lymphatics in the groin become involved, and secondary deposits follow. The diagnosis from syphilis rest chiefly on the character of the base, which is covered with decaying epithelium, and the intense induration beneath and around.

Amputation is the only treatment. Until recently this was accomplished either with a single sweep of the knife, or more deliberately, forming a flap of skin to cover the surface of the wound, leaving the corpus spongiosum and the urethra longer than the rest, and stitching the edge of the mucous membrane to that of the skin. Recurrence, however, is exceedingly common after this operation; cicatricial stricture at the orifice invariable; and all power of directing the stream of urine lost. To avoid this Thiersch recommends an oval incision round the root of the penis, prolonged a little backward in the median raphé of the scrotum, and then dissecting off the whole of the corpora cavernosa from the rami of the pubes and the triangular ligament. The corpus spongiosum and the urethra are dealt with separately, through an incision in the median line of the perineum behind, as much being removed as appears desirable, and the rest sutured to the skin in front of the anus. Micturition must, of course, be effected in the sitting posture, but there is not the same tendency to the formation of stricture, and there is much further freedom from return of the growth.

Wheelhouse has pointed out the greatly increased comfort the patient experiences when the testes are removed as well.

## DISEASES OF THE SCROTUM.

*Œdema* may occur in Bright's disease, causing enormous swelling; and a similar affection (probably inflammatory in origin) is occasionally met with in infancy.

*Inflammation* is very common, but unless the cause is very grave (as in extravasation of urine), or the nutrition much enfeebled, as in specific fevers, sloughing and gangrene rarely occur. It may arise from injury, eczema, the irritation of the urine, or retained perspiration, or it may start from the interior, or spread from other tissues. The swelling is usually immense, but the other signs, pain, heat, and redness, are seldom in proportion.

*Elephantiasis.*—Enormous hypertrophy of the tissues of the scrotum may be caused by lymphatic obstruction, or by repeated attacks of inflammation, as in cases of urinary fistula. The skin and subcutaneous tissues only are affected, the cellular elements and the fibrous tissue being immensely increased, while all the interstices are filled with lymph, or in rarer cases with a mixture of this with chyle. Hydrocele is usually associated with it, and the skin of the penis may become involved, but the testes are never affected (see p. 291).

*Epithelioma* is of interest from the fact that its origin can nearly always be traced to local irritation caused by soot—whence its common name, chimney-sweep's cancer.

It begins as a wart or nodule, which slowly spreads at the margin as it decays and ulcerates in the centre. Induration is its chief feature. The edges are raised, hard, and ill-defined; the base is covered with decaying epidermis and florid granulations which discharge a thin, offensive fluid, and the tissues around are swollen and œdematous. At first it can be pinched up from the structures beneath, and merely feels like an induration in the skin; soon it infects the lymphatic glands in the groin, spreads to the rest of the scrotum and the penis, and involves the testicles as well.

Fortunately, its character is so well known among those liable to it (soot may cause it in other parts of the body, and there is reason to believe that tar may do the same), and its progress (for epithelioma) is so slow, that removal in time is usually possible. Even if the inguinal glands are enlarged and broken down, the whole of the disease may sometimes be successfully scraped out.

## EXAMINATION OF SCROTAL SWELLINGS.

Swellings of the scrotum are divided into those that occupy the canal as well as the scrotum, and those that are confined to the latter situation. The distinction is made by feeling the cord immediately below the pubes, whether it is the natural size, with all its components distinct, or whether it is thickened or concealed in any way.

### 1. Swellings that Occupy the Canal as well as the Scrotum; of these, some are Reducible, others are not.

#### (*a*) *Reducible.*

*Bubonocele* and *scrotal hernia* may be recognized by the way in which they disappear, whether they consist of intestine or omentum.

*Varicocele*, by its characteristic feel, the way in which it disappears when the patient lies down and the scrotum is raised, and refills in spite of the pressure of the finger on the ring.

*Congenital hydrocele*, by its translucency. As the neck of the canal is often long and narrow, reduction is not always easy.

#### (*b*) *Irreducible.*

*Hernia*, either because it is *strangulated* (in which case there is no impulse on coughing), or because it is *irreducible*, *i. e.*, so altered in shape, or so tied down by adhesions, that it cannot pass back. In strangulation, constitutional symptoms are present as well.

*Infantile Hydrocele.*—The neck of the tunica vaginalis is obliterated only at the internal abdominal ring, and a collection of fluid extends from the bottom of the scrotum along the inguinal canal. The slow formation, commencing below and extending upward, the translucency and the absence of true impulse (if it extends really into the canal there may be a kind of shock transmitted), are distinctive.

*Inflammatory Affections of the Cord.*—In urethral epididymitis this is some-

times swollen to a considerable size; in tubercular disease the vas only is thickened, and all the structures of the cord can be isolated.

*Growths on the Cord.*—The most common is *encysted hydrocele*, a small, round, and tense fluid swelling, due to incomplete obliteration of the funicular portion of the tunica vaginalis. It is movable in the canal, but cannot really be reduced, and it is adherent to the cord, forming part of it and moving with it.

*Lipoma, sarcoma*, and other growths may occur, but they are very rare. Secondary infiltration is always present in malignant disease of the testis, if the gland is not speedily removed. *Hæmatocele* of the cord has been described.

### 2. Swellings Confined to the Scrotum.

#### (*a*) *Those Connected with the Scrotum Itself.*

*Œdema.*—In Bright's disease, the whole scrotum sometimes becomes enormously distended, without the legs being much affected. A moment's consideration is sufficient, but I have known serious mistakes made.

*Elephantiasis.*—In the tropical variety there can be no hesitation, but occasionally a greatly thickened and hardened condition, not so plainly recognized, is met with as a result of neglected stricture.

*Lipoma, epithelioma*, and other varieties of new growths may occur.

#### (*b*) *Those Connected with the Testis and its Coverings: these may be solid or fluid.*

The former include inflammatory diseases and tumors of the testis. The chief difficulty occurs with hæmatocele and old hydrocele, the walls of which may be so thick that they are practically solid.

The latter may be connected with the tunica vaginalis (hydrocele or hæmatocele); the testis or epididymis (encysted hydrocele); or the lower end of the cord (hydrocele of the cord); or they may be independent cysts—dermoid, for example, or hydatid. Some difficulty may arise from what is known as hydrosarcocele, a collection of fluid in the tunica vaginalis, surrounding and concealing an enlargement of the testis, and the diagnosis may remain uncertain until the fluid is drawn off.

## Malformation of the Testes.

The full development of the testis is not reached until sexual maturity. It may fail: (1) either in its original formation; (2) in its evolution (including its descent into the scrotum); or in both together. In addition, it occasionally happens that, though perfectly developed, it becomes displaced (malposition).

(1) *Defective Formation.*—The testis and epididymis are developed independently of each other, although they are in close connection; sometimes one fails, sometimes the other. If the former, the epididymis and the vas may occupy their normal situation, the gland itself being represented only by a nodule; if the latter, the testis may be well developed and of its normal size, although its secretion fails to reach the urethra. Sometimes the whole of the epididymis is wanting; more frequently only part, and the vas terminates blindly. If both testicles are wanting, sexual development at puberty does not take place, and often there is malformation of the other organs.

(2) *Defective Evolution.*—The testis may fail to attain the normal size, or its normal position, or both.

(*a*) *Imperfect Evolution of the Testis when in its Normal Situation.*—In most instances the cause is unknown; the subject of it when the affection is bilateral, has an effeminate appearance; the voice does not break; the larynx remains small; there is no growth of hair, and the limbs are smooth and rounded. When it is unilateral, it is often associated with varicocele, but it is more probable that they are both dependent upon the same cause, whatever that may be, than that one is the consequence of the other.

(*b*) *Non-descent.*—Descent of the testis may be delayed, or may fail to take place, wholly or in part. In the former case, the testis is usually well developed, and the descent is completed at puberty, when the organ becomes sexually mature. In the latter it is usually small and flabby.

The cause is very uncertain, except in those cases in which there is a distinct mechanical impediment, such as fusion of the two glands. Adhesions to neighboring structures (especially the intestine) are often present, but there is no proof that they are the reason. The gland may remain in the original position, or be arrested in the iliac fossa, or in the inguinal canal. The sac of the tunica vaginalis nearly always remains open; hernia is, in consequence, very often present as well, and, if not, is always liable to occur; and, not infrequently, owing to slight attacks of inflammation, there are adhesions between the intestine and the gland.

The **symptoms** and **treatment** depend upon its position and mobility.

If it lies in the iliac fossa, it is well out of the way of injury, and nothing is required but a truss to prevent the development of hernia.

If it lies in the inguinal canal and is sufficiently movable to pass out of the external ring, the same treatment may be adopted, a horseshoe-pad being used to avoid undue pressure upon it.

If it is fixed between the muscles the conditions are different. In most cases a truss cannot be worn, and there is constant danger of hernia. The gland itself is always liable to injury and inflammation; if this occurs, satisfactory evolution at puberty is improbable; and, like other ill-developed organs, it is liable to become the seat of malignant disease. Under these circumstances, if the tendency to hernia cannot be prevented, or if there has been an attack of inflammation, the gland is better removed. It is, in all probability, functionally useless, and is a constant source of danger.

In cases of strangulated hernia the treatment of the gland depends upon its condition. If it appears fairly well formed and not too much tied down by adhesions, and if the vas is of sufficient length and the scrotum will admit it, an attempt may be made to transplant it. If this cannot be done it should be excised.

3. *Malposition.*—The testis may be in its normal position, but inverted; the epididymis and the vas deferens lying in front of the other structures. If hydrocele or hæmatocele occurs, and this condition is not recognized, the gland is liable to be punctured instead of the tunica vaginalis.

In other cases the testis passes out through the inguinal canal into the perineum, or misses this altogether and slips into the crural ring, even passing out on to the thigh. The treatment consists either in transplantation (waiting until the child is two or three years old) or excision, according to the condition of the scrotum and the gland and the amount of inconvenience it is likely to cause.

## Neuralgia of the Testis.

Pain and retraction of the testis are of frequent occurrence in disease of the kidneys and affections involving branches of the lumbar plexus; further, after obliteration of the vas, sexual intercourse, or even excitement, may be attended with severe pain and swelling of the gland; in addition to this, however, the testes in certain people are liable to attacks of intense neuralgia, coming on at regular intervals or excited by the most trivial irritant. Usually one only is affected, but both may be; the gland may be apparently well nourished, or it may be small and flabby; it may be exceedingly irritable, resenting the slightest touch, or there may be nothing noteworthy about it.

In many cases there is a history of injury, but it seldom stands cross-examination. Gout, malaria, anæmia, and other constitutional ailments are sometimes present. It may occur in the most continent; and though in many there is a history of abuse, it is difficult to connect one condition directly with the other. Sexual hypochondriasis may be associated with it, and often the family history is decidedly neurotic.

**Treatment** is very unsatisfactory. Any local or constitutional cause that can be detected must, of course, receive thorough consideration; a suspender must be worn; lead, or some other cooling lotion applied; and the thoughts and ideas as far as possible directed into other channels. Cupping over the loins, massage of the back, and the free (local) use of anodynes may be tried as well. If there is a large varicocele, operation may give relief, but castration is useless.

### Atrophy.

Rupture or ligature of the spermatic artery and occasionally acute orchitis (especially that variety which is associated with mumps) are the chief causes, the testicle shrinking to a small nodule. I have known the same thing occur after a blow. Rupture or ligature of the vas deferens, chronic epididymitis, the pressure of ill-fitting trusses, and abuse, may be followed by the same effect; but the wasting is seldom so extreme. Whether it is ever a result of varicocele is doubtful, though this is so often associated with a soft and flabby condition of the gland.

The opposite result, hypertrophy, is said to occur as compensation in cases of unilateral retention.

## ORCHITIS AND EPIDIDYMITIS.

Inflammation of the testis may be caused by injury, morbid conditions of the blood, as in gout or rheumatism, extension from the neighboring structures, or the presence of specific irritants, such as those of tubercle and syphilis. It may affect the testis, only or chiefly (orchitis); or the epididymis (epididymitis); and it may be acute or chronic, ending in resolution, organization, caseation, or suppuration, according to the cause. In addition, acute orchitis is sometimes due to "metastasis" in connection with mumps, but only after puberty, and not apparently with equal frequency in all epidemics.

### 1. Acute Inflammation.

(*a*) *Acute orchitis* may be caused by metastasis (the parotid is occasionally not affected), injury, or pyæmia; or it may be due to extension from the epididymis or tunica vaginalis. Subacute attacks are not uncommon in gout and syphilis.

The gland is swollen and exquisitely tender, but owing to the toughness of the tunica albuginea it retains its shape, and is not so large as in epididymitis, or flattened on the side. The skin is red and œdematous; the temperature raised, the veins swollen, and the cord thickened and tender, but the structures composing it are not matted together, and the vas is but little affected. The tunica vaginalis is filled with fluid (acute hydrocele) and sometimes obscures the local signs altogether—there is merely evidence of intense inflammation without its being possible to say from the appearance of the swelling whether it is confined to the tunica vaginalis or involves the testis inside. Pain is always severe and of a peculiarly sickening character, with heavy dragging in the loins; and the constitutional symptoms are often very grave, delirium sometimes occurring in the metastatic variety.

Localized peritonitis with spasmodic contraction of the abdominal muscles is not unfrequent when a retained testis is inflamed, and it has been known to prove fatal.

(*b*) *Acute epididymitis* is nearly always due to extension from the urethra, though the actual outbreak is often determined by local injury. It may be caused by any irritation affecting the prostatic portion, gonorrhœa (not the acute stage,

but later when the gleet is chronic), impacted calculus, injections, lithotrity, or even the passage of a catheter. Exceptionally it follows injury alone, or occurs in the course of pyæmia. Subacute varieties are met with in the early stage of secondary syphilis, and occasionally as a result of stricture and chronic urethritis. This is of special importance, as sometimes, when there has been no acute attack, the enlargement closely resembles that due to tubercle before caseation has begun.

The general symptoms are the same as those of acute orchitis, but the two affections can nearly always be distinguished. The shape is different; instead of being rounded, it is flattened by the pressure of the thigh upon the outer side; and the testes can be felt, soft and almost painless in the front. The skin is red and œdematous, especially behind and below, and it cannot be pinched up into a fold or lifted off the subjacent structures. The pain begins in the loins before there is local tenderness, and in the same way the groin may be exquisitely sensitive before the testis is affected. But the most important point of all is the condition of the cord: the vas deferens is enlarged; the cord immensely thickened; and all the structures in it matted together so that they cannot be isolated. Epididymitis is rather more common upon the left side than the right, and seldom involves both at the same time, though the second is frequently attacked as the first is getting well.

The urethral discharge ceases so long as the inflammation is acute, and begins again as it subsides.

**Termination.**—Acute inflammation, whether it involves the testes or the epididymis or both (for it not unfrequently extends from one to the other), usually ends in resolution, but not always. Partial organization may occur, affecting especially the exudation in and around the globus minor. An indurated mass is left, painless, gradually sinking into a small, hard nodule, apparently insignificant, but often leading to obstruction or stricture of the vas. If it occurs on both sides and does not undergo speedy resolution the subject is sterile. Atrophy may occur, and in the case of orchitis be complete. Epididymitis, even when the vas is obstructed, seldom leads to this; sexual intercourse may be very painful and be followed by the swelling of the gland, but unless the artery is obliterated at the same time the testis seldom wastes altogether. A curiously irritable condition sometimes persists, the testis and even the skin of the scrotum remaining exquisitely tender. Suppuration occasionally follows; gangrene of the scrotum and sloughing of the testis have been known; and tubercular disease is not uncommon. Whether epididymitis has any connection with the vaginal hydrocele that so frequently develops in later life is uncertain. The acute effusion that accompanies the attack subsides with it, though it may leave permanent adhesions, and sometimes causes obliteration.

**Treatment.**—If possible, the patient should be confined to bed with the scrotum raised on a small pillow between the thighs. In other cases a suspender must be used, but the effect is not nearly so good. The bowels should be freely opened, liquid diet only allowed, and rest ensured by means of morphia or chloral. In young plethoric patients, with a hard, bounding pulse, full doses of antimony may be given at frequent intervals until there is a distinct feeling of nausea, but this is of no good after the first twenty-four hours, and only when the fever begins with severity. Smaller doses three times a day are useful later, if the skin continues hot and dry, or the headache is severe.

In urethral epididymitis cold is by far the best application, especially at the beginning. An ice bag may be laid upon the part, or Leiter's coils used, lead lotion being substituted after twenty-four hours. If the patient cannot remain in bed, the skin of the scrotum should be covered over with extract of belladonna and glycerine; and then, the other testis being pushed out of the way, surrounded with many layers of cotton-wool and subjected to gentle compression by means of a laced-up bag suspender. A few common rubber bands may be placed outside

this with advantage. The application should be renewed at least twice a day, the patient fomenting the part each time with hot water, or, better, sitting in a hot bath. If the belladonna causes any irritation, lead may be substituted for it. The urethra should, of course, be left alone, not only during the inflammation, but after it has subsided.

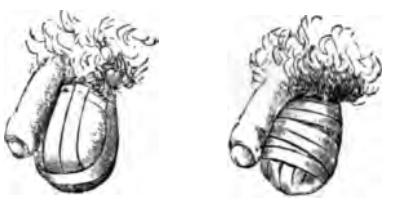


FIG. 489.—Strapping Testicle.

If the effusion into the tunica vaginalis is at all considerable, a few punctures may be made with a fine tenotomy knife, or an ordinary trocar and cannula may be introduced; and if the veins of the scrotum are distended, they may be pricked and encouraged to bleed; or leeches may be placed upon the inguinal canal; but, although it is largely practiced by some surgeons, and apparently with impunity, puncture of the testis itself is not advisable.

Later, when the acute symptoms are beginning to subside, the testis should be strapped. The affected organ is separated from its fellow, and isolated by winding round above it a long, narrow strip of soft leather covered with emplastrum plumbi. The end that is applied first should be narrower than the other, so as to prevent the edge cutting into the skin. Then narrow strips of ordinary plaster are arranged so as to cover the whole organ evenly, beginning from the horizontal piece in front, passing down round the bottom of the scrotum, and ending on it again behind. Afterward a circular piece is placed over all the ends to keep them secure. If a small nodule obstinately persists, mercurial ointment may be rubbed in over it, or a thick layer of it may be applied upon lint under the strapping, but care must be taken that it does not irritate the skin.

Traumatic orchitis may be treated in the same way. When due to metastasis warm fomentations are better from the first; and if there is much infiltration of the scrotum, so that the condition of the circulation is doubtful, or if the patient is old and feeble, cold should not be used, for fear of gangrene.

### 2. CHRONIC INFLAMMATION.

This may begin as such or be the relic of an acute attack. When confined to the body of the testis it is nearly always due to syphilis; gout and malaria are exceptional causes. If the epididymis only is concerned, it is probably tubercular or urethral, and in the latter case it may be either the remains of an acute attack or chronic from the first. Syphilis occasionally affects the epididymis only (in the early secondary period), and not unfrequently both epididymis and testis.

The **diagnosis** is usually straightforward; but sometimes, when it commences insidiously, without any obvious degree of inflammation, involving the body of the gland, and not the epididymis, and affecting one side only, it is difficult to distinguish it from incipient malignant disease, except by watching the progress of the case and the effect of treatment.

#### (*a*) *Syphilitic Inflammation.*

Subacute epididymitis may occur in the early secondary stage, a painful irregular swelling making its appearance at the back of the testicle, involving the cord to a slight extent. It never possesses the severity of urethral epididymitis; the skin may be reddened, but it is not œdematous; and, like the other secondary symptoms with which it occurs, it subsides rapidly under mercury.

True orchitis appears later, either during the intermediate period (when both

glands are involved), or with the tertiary symptoms, when one is often attacked long before the other. As a rule, it does not affect the epididymis or the cord, and is very chronic in its progress; but often, in neglected cases, after the first testicle has been enlarged for some time, the second suddenly becomes actually inflamed, the skin grows hot and red, the tunica vaginalis distended, the epididymis affected as much as the testis, and the pain so severe that the patient is compelled to apply for relief.

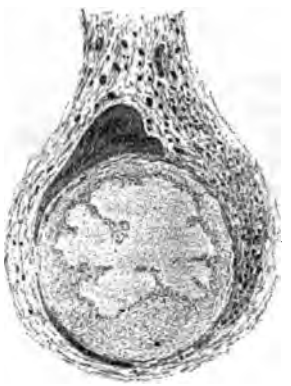


FIG. 490.—Syphilitic Disease of Testis; a Central Gumma.

**Symptoms.**—The character of the swelling depends upon the distribution of the syphilitic exudation, and the changes it undergoes. In some cases, especially the earlier ones, there is uniform enlargement of the whole gland, so that it remains ovoid, smooth, and even, and merely becomes heavy and intensely hard; in others the surface is nodular and uneven in consistence, dense indurated patches alternating with others that are soft and elastic. The exudation, in other words, may be uniformly distributed throughout the whole of the fibrous tissue of the gland; or aggregated either into one central gumma or into numerous scattered ones of various sizes; and, according to the success of the treatment, it may be completely absorbed, merely leaving a slight depression, or become organized into cicatricial bands, or break down and undergo caseation and liquefaction. Occasionally this ends in suppuration and hernia testis; more frequently partial absorption takes place, and a hard irregular mass is left, sometimes in the middle, sometimes at one side of the testis, composed of a caseous or even calcareous centre, surrounded by an immense thickness of cicatricial tissue—a so-called chronic abscess.

The size a testicle may reach under these conditions is something enormous; usually when large it is painless and devoid of testicular sensation. Heat, redness, thickening of the cord, œdema of the skin, and effusion into the tunica vaginalis are signs of acute inflammation, and are only present when the testicle is first attacked, or when a fresh gumma suddenly develops. I have known cases of this kind to last for ten years, with occasional subacute attacks compelling the patient to apply for relief, until at length the testicles were enormously enlarged, irregular in shape, hard, painless, and absolutely devoid of sensation.

The **diagnosis** of syphilitic orchitis is rarely difficult; the only form that resembles it is that which occurs in gout. The chief features are the essentially chronic character of the affection (varied from time to time by more acute attacks); the smooth, hard, heavy character of the swelling; the disappearance of the epididymis, which in many instances is so flattened out that it cannot be felt (occasionally it is enlarged); the absence of pain (during the greater part of the time), and of testicular sensation; and the fact that both testes are involved, though rarely equally.

**Treatment.**—In epididymitis and recent orchitis, mercury may be given freely with a view of causing speedy absorption; later, especially if the disease has relapsed, more benefit is derived from small doses of bichloride, continued with occasional breaks. Iodide of potash always causes a rapid diminution in size, but absorption of the syphilitic exudation is rarely complete; it progresses up to a certain point, continues as the dose is increased, and then comes to a standstill, leaving a dense mass, over which nothing appears to have any influence. The acute symptoms, however, are quickly relieved by it. Occasionally other remedies are of service: mercury, for example, rubbed into the skin on the inner side of the thigh (it cannot be applied to the scrotum), strapping, or the removal of hydrocele fluid. If suppuration occurs, the abscess must be opened; and at length, if the testis becomes useless, and is a constant source of pain and suffering, castration

### (*b*) *Tubercular Disease.*

This is most common about puberty and in young adult life, although it may develop at any age, and it may be either primary, and followed by extension to other organs, or secondary, sometimes occurring as part of general tuberculosis. Except in this case (which from the condition of the patient rarely admits of diagnosis during life) it always begins in the epididymis as a deposit of gray miliary tubercle in the lymphoid intertubular tissue. From this it may spread into the body of the gland, working its way through the mediastinum testis, and infecting the lymphoid tissue around the tubuli seminiferi; or up the vas, to the vesiculæ seminales, prostate, and bladder; or it may, under happier circumstances, after attaining a certain size, gradually cease to enlarge, and either discharge itself externally as a mass of caseous debris, or undergo calcification or fibroid degeneration. One side is usually attacked first, but it rarely happens that the other remains exempt for long.

**Symptoms.**—The beginning is rarely noticed: a hard nodule, already of some size, is usually discovered accidentally at the back of the gland. It is quite painless; there is no hydrocele, and scarcely any inflammation; it is only slightly tender even on pressure, and testicular sensation is not impaired. At first it may be rounded or irregular, but after a time it becomes crescentic, and grows out above and below the testis as well as behind. The gland itself is rarely affected at this stage.

Sometimes this diminishes in size, and becomes harder and more irregular, probably undergoing fibroid degeneration. More frequently it continues to increase; one part becomes softer than the rest; the skin over it grows red and adherent; then becomes thinner and thinner until it breaks, and gives exit to a turbid caseous liquid resembling pus. Occasionally even then the morbid process ceases; more frequently other deposits break down; more sinuses form; the testis and vas become involved; and at length secondary deposits make their appearance elsewhere. Hernia testis may occur, although it is not so common as in syphilis.

**Diagnosis.**—Urethral epididymitis is usually acute. Sometimes it is chronic from the first; but then there is seldom a real increase in size; there is merely a certain degree of induration, usually limited to the globus minor. The secondary syphilitic form disappears within a week or ten days, under mercury. Cysts may cause a little trouble, but when they occur in connection with tubercular epididymitis they are never very large or distinct.

**Treatment.**—Constitutional measures are of the highest importance; in the early stage, when the diagnosis is still uncertain, or before the patient will allow an operation, they may succeed in arresting the disease; in the later, when there is no longer any hope of effecting a cure by local measures, they will often check it for a time. Perfect rest, especially avoidance of sexual excitement, is most important; sea-air, often a long sea-voyage, answers better than anything; the food must be nutritious; a moderate supply of stimulants allowed; and tonics, especially cod-liver oil, given freely.

FIG. 491.—Tubercular Disease of the Epididymis with Miliary Deposits in the Testis.

The local treatment depends upon the stage the disease has reached. If the globus minor is merely indurated, without there being any definite increase in size, as compared with the other one, or any distinct nodule, the condition of the urethra should be carefully examined, and the testis strapped over iodide of lead ointment. In most cases, however, this stage is already past, and there is a definite nodule, often commencing to soften, at the back of

the testis, or even several of them. If the rest of the epididymis is free, and the vas not thickened, an attempt may be made to arrest the progress of the disease by laying it open, scraping out all the tubercular tissue, and plugging the cavity with iodoform. Such a state of things, however, is rare; nearly always the whole epididymis is affected, and the vas distinctly enlarged before the patient applies for treatment. Under these conditions, if the opposite gland is sound, and no enlargement of the vesiculæ seminales can be detected, the diseased organ should be removed at once, the vas being divided as high up as possible. When the disease is more advanced, much may still be done to husband the patient's strength; sinuses may be scraped out and filled with iodoform; the testicle carefully protected; the inflammation checked by lead lotion or belladonna; and if there is any serious amount of discharge, weakening or distressing the patient, or if hernia testis forms, castration may be performed.

### (*c*) *Gouty Orchitis.*

This is much more rare than either the syphilitic or tubercular variety, and in many of the cases in which it is assigned as the cause the evidence of gout is not so clear as might be wished. Subacute orchitis, however, is not uncommon in men past middle life, especially those of gouty habit, and occasionally is distinctly associated with gout. The testis itself is involved, not the epididymis; a certain amount of hydrocele is usually present; the pain and inflammation are severe, though not to the same extent as in urethral epididymitis; and some chronic induration is not unfrequently left.

In addition to this, subacute orchitis may occur in connection with urethral arthritis, hereditary syphilis, and possibly other disorders.

### 3. Suppuration.

Acute orchitis, unless it is due to pyæmia, rarely breaks down and suppurates. In urethral epididymitis this termination is rarely more common, but the abscess is seldom acute. Most cases arise in connection with syphilis or tubercle, suppuration either occurring around the caseous mass before it breaks the skin and makes its way out, or, after this has happened, in which case the pyogenic organisms may gain entrance through the wound. In any case the abscess should be opened as soon as possible and drained.

## HERNIA TESTIS.

Hernia testis, like hernia cerebri, is a protrusion of the substance of the organ through an opening in its unyielding capsule, due to inflammation. Suppuration is not essential to its production, but it is so uniformly present that it is usually regarded as the cause; the opening in the capsule might, however, be produced in other ways, and the increased tension in the interior and softening of the subjacent layers might arise from other causes, such as syphilis or tubercle.

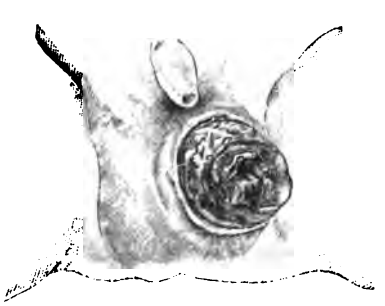


Fig. 492.—Hernia of the Testicle following Tubercular Disease, removed from infant, æt 2.

Hernia testis must be distinguished from "malignant fungus" of the testis or "fungus hæmatodes"—the protrusion of a malignant growth through the coats; and also from what has been called "false hernia"—a prolapse of the testis, covered with a layer of granulations, through an opening in the tunica vaginalis and scrotum.

In the majority of cases hernia testis is due to syphilis; a gumma forms in the substance of the organ and breaks down; the layers of the tunica vaginalis fuse with each other and with the skin; this grows

thinner and thinner, until at last it gives way, exposing a cavity filled with caseous or sloughing debris, and lined by a still growing layer of syphilitic exudation. The external pressure is removed by the rupture of the fibrous wall, and if the syphilitic growth or the suppuration is active, a mass, sometimes of granulations, sometimes of the tubuli seminiferi themselves, is forced out through the orifice by the vascular tension. The same thing may occur with tubercle when this involves the testis, and with other forms of suppurative orchitis.

The appearance is characteristic. A soft, red, granular mass, occasionally covered with sloughs or caseous debris, projects through an opening in the scrotum, to the margins of which it is closely adherent. In some instances it seems as if the whole testis is driven out, and the edges of the opening are everted and concealed beneath a mushroom-shaped mass; in others there is merely an open sore with protuberant granulations at the bottom. It does not bleed very readily (like the malignant form), and, as there is now no tension, is not very painful; but, particularly in the tubercular variety, it may prove a serious drain upon the patient's strength.

**Treatment.**—As in hernia cerebri, the first point is to stop the inflammation. If this can be done the protrusion soon subsides spontaneously; the wound becomes a granulating sore, and cicatrization begins. Occasionally, if the surface is perfectly clean, this may be hastened by Syme's operation—removing the narrow edge of unhealthy skin around it by means of two elliptical incisions, one on each side, and drawing together the margins over it, but it often fails. In tubercular cases, in which the testis is practically destroyed and the caseous process will not cease, castration is usually advisable, not with a view of curing the patient so much as of relieving him of a source of infection and a constant drain upon his strength.

## TUMORS.

*Dermoid* and *hydatid cysts* are occasionally met with. The former may be recognized by their congenital origin (though they often do not attain much prominence until late in life) and uneven consistence; but no certain diagnosis can be made without puncture.

*Cystic adenoma* is more common. Like parotid glandular tumor, it is peculiar to the organ from which it springs, and only admits of a somewhat vague comparison with other growths. It consists of cysts of all sizes, lined with cubical or flattened epithelium, filled with a clear brownish or greenish fluid, and developed from the tubuli seminiferi, the epithelium of which has either lost or has never acquired its distinctive characters. In between is a variable amount of fibrous tissue, sometimes undergoing myxomatous degeneration, and occasionally mixed with cartilage. Intracystic growths may occur as well.

FIG. 493.—Cystic Disease of the Testicle.

Tumors of this kind may occur at any age, but they are rarely noticed before puberty. Growth is slow and painless, the patient suffering no inconvenience other than that due to the weight. The vas is never affected, and secondary deposits do not occur, the cases in which this is said to have taken place having really been sarcomata, with an accidental development of cysts.

*Fibroma and enchondroma* of the testis are met with in young adult life, but they are both very rare. The chief clinical feature is the slow growth of a

hard and heavy painless mass. The surface is usually smooth, but it may be nodular and suggest the presence of cysts. Growths of this kind do not extend along the cord, invade other organs, or recur; but removal is always advisable. There is no means of distinguishing one from the other but by section.

*Carcinoma* of the testis is nearly always encephaloid, though a few cases of scirrhus have been described. It is stated to be most common between twenty and forty years of age. The beginning is usually very insidious; the testis is enlarged, smooth, ovoid, and at first fairly firm, the cord is not thickened, nor are its components matted together, but it feels fuller than the other, and the veins over the scrotum are distended. There is little or no pain or tenderness, and testicular sensation is soon lost. In a very few weeks there is a rapid increase in size; the tumor is softer, the surface uneven, the cord distinctly thickened, the shape becomes globular, and the epididymis flattened out at the back. If left, it becomes so soft that it almost seems to contain fluid; the skin becomes adherent, the veins are more distended, the thickening extends higher up the cord, and, perhaps, if the patient is thin, an ill-defined sense of resistance can be made out by deep pressure at the back of the abdomen. Soon the skin of the scrotum gives way, allowing a bleeding mass to protrude, the glands of the groin enlarge, secondary deposits make their appearance in other organs, and the patient sinks rapidly from exhaustion.

*Sarcoma* of the testis presents greater variety of appearance and character. It may be round-celled, or spindle-celled; and the latter especially may become more or less converted into cartilage (without, however, losing one atom of its malignant sarcomatous character); sometimes there are only nodules here and there, sometimes branching outgrowths, due, perhaps, to the spreading of the disease inside the lymphatics, and occasionally so much that the original sarcomatous growth is hard to find. In addition, both of these forms may be associated with cysts, due either to softening and hemorrhages, or to distention of the seminiferous tubules, with proliferation of the epithelium lining them, and occasionally intracystic growths, so that they may present a close resemblance to some of the forms of cystic adenoma.

Sarcoma may occur at any age, even before birth, though it is most common under ten years and between thirty and forty. The round-celled variety, unless the patient is a child, or both testicles are attacked at once, cannot be distinguished from encephaloid carcinoma; the progress is as rapid, and the glands of the lumbar and other regions are involved as soon; if possible it is even more fatal. The other variety is much less uniform in rate of growth and consistence; it may, for example, be formed almost wholly of cartilage or fibrous tissue; cysts are less common; and it does not appear so ready to fungate; but the ultimate results, the infiltration of the glands with growth of the same histological character as the primary one, and the secondary deposits in the lungs and other organs, are equally certain.

**Treatment.**—Sarcoma and carcinoma should be removed as soon as the diagnosis is made, the cord being divided as high up as possible. The prognosis is very unfavorable, but in all probability this is due in some measure to delay; there is evidence to show that if castration is performed in time recurrence may not take place for many years. Even if the skin is involved, and the cord thickened, the operation is advisable to save the patient from the formation of a fungus, if only there is reasonable prospect of securing immediate union of the wound.

### Diagnosis of Tumors of the Testes.

*Age.*—A tumor that appears in infancy is probably hydrocele; sarcoma, syphilitic and tubercular orchitis do occur, but they are very rare in comparison.

*Etiology.*—A definite history of accident deserves consideration, though it may have merely drawn attention to an already existing, but unsuspected, enlargement. Sarcoma may follow injury as well as hæmatocele.

*Rapidity of Growth.*—Hæmatocele is an affair of minutes, or at most of hours, malignant disease of a few weeks. Acute orchitis presents no difficulty; chronic inflammation, on the other hand, if only one side is involved, if there is no evidence of constitutional complaint, and if there is but little heat or pain, and no redness, can often only be diagnosed by the results of treatment. Syphilitic orchitis, for example, may, so far as a single examination is concerned, be indistinguishable from incipient malignant disease.

*Duration.*—If the tumor has lasted more than six months, without the doubt clearing up, it is not malignant.

*Consistence*, whether solid or fluid. Hydrocele and hæmatocele are the only fluid tumors at all common, but there are many sources of fallacy. A hydrocele may conceal an enlargement of the testes (hydro-sarcocele). Old hydroceles and hæmatocele may have walls of such thickness as to appear solid; and rapidly growing malignant tumors may be as soft and elastic as if they contained fluid.

*Translucency.*—This separates off at once thin-walled hydroceles.

*Number.*—Hydrocele and sarcoma may occur on both sides, but nearly always, when both testes are affected, the tumor is of inflammatory origin.

*Shape.*—If the tumor retains the shape of the testis, it is probably either chronic inflammation or incipient malignant disease. Sarcoma and carcinoma when more advanced, hæmatocele and encysted hydrocele, are spherical; other tumors are very irregular.

*Pain and Sensitiveness.*—Hæmatocele may be very painful at first: the others (except acute inflammation) are rarely attended by pain. In chronic orchitis, malignant disease, and hæmatocele testicular sensation soon disappears.

*The Condition of the Cord.*—In chronic orchitis, hydrocele, and hæmatocele the cord is not affected. In acute inflammation and incipient malignant disease it feels full because of the increased amount of blood. In acute epididymitis and advanced sarcoma and carcinoma it is thickened and all its component structures welded together. The vas itself is enlarged in tubercular epididymitis.

The skin is not adherent unless there is acute inflammation or advanced malignant disease.

Hæmatocele can only be distinguished from incipient malignant disease by the rapidity of its development, its history, or the result of puncture. Even this, however, may deceive; on one occasion I tapped a blood-cyst in the centre of a sarcoma.

Chronic orchitis in some cases can only be diagnosed from incipient malignant disease by the effects of treatment; but not more than a fortnight should be allowed.

## Castration.

The linear incision from the external abdominal ring down to the bottom of the scrotum is all that is required, unless, as in the case of a malignant growth, or of hernia testis, the cutaneous coverings are adherent to the deeper structures. The skin should be made as tense as possible to avoid any jagging, and the cord exposed at once. As soon as this is isolated the testis can be protruded through the wound. In the case of malignant disease or tubercular infiltration, the inguinal canal should be slit up on a director, and the cord drawn down as far as possible before securing it.

The usual method is either to pass a single ligature round the cord (silk should be used) or to tie each vessel separately as it is divided, leaving the vas to the last. As, however, the ligatures may slip in both of these, causing severe and deep bleeding when the cord retracts, and as the latter is very tedious, Jacobson recommends that a double ligature should be passed through the substance of the cord, the loop cut, and the two halves tied separately. Then the ends of the one are cut short, while the other is tied again round the whole thickness. If possible the cord should be divided well above the disease. No drainage tube is necessary if the dressing is carefully arranged around the wound.

The testis should always be examined before the cord is tied, in case of a mistaken diagnosis, and the cord should never be divided until it is certain that the ligature is secure.

### VARICOCELE.

By this is understood a varicose condition of the veins of the spermatic cord, often associated with a diminution in size and loss of tone of the testis, and a peculiar flabby relaxed condition of the dartos. It is very much more common on the left side than the right, and if it occurs on both it is always worse on the left.

FIG 494.—Varicocele.

**Etiology.**—It is rarely or never noticed before the period of functional activity of the testis, and is probably the result of some developmental defect. The various causes that have been assigned, the length and direction of the veins, their imperfect support, and the vascular changes that attend too early intercourse, or abuse, act on both sides alike; and the reasons given for the predominant frequency of the left—the pressure of the sigmoid flexure, the greater length of the veins on that side, and the opening into the renal—are insufficient, as causes, though they may make the condition worse. The valves in the veins are thoroughly competent.

**Symptoms.**—These bear no relation to the size; a very large varicocele may exist without the patient knowing it. Complaints are most common in young adult life, or much later, when sexual power is failing. There may be tenderness and irritability of the testis, sometimes amounting to severe pain; but the chief feature is a constant dragging and weight in the loins, made worse by standing, exercise, constipation, or sexual intercourse—anything, in short, that increases the congestion. With this there is frequently associated a most distressing mental condition; the patient is subject to periods of intense depression; he is always thinking of himself; often he believes that he is failing in power from some old indiscretion; and not unfrequently he becomes a confirmed hypochondriac at last.

The skin of the scrotum is so lax that the testicle hangs far below its proper level; the cord is surrounded by a soft, irregular mass of dilated veins (like a bag of worms) obscuring the gland below, and ceasing at the abdominal ring; and the testis itself is often small, soft, and flabby. There is a distinct impulse on coughing; the veins empty themselves spontaneously as soon as the patient lies down and the scrotum is raised; and if, after this, he stands up again they gradually refill from the bottom in spite of firm pressure over the ring.

Allusion has already been made to the relation between the testis and the varicocele; the morbid condition in both is probably dependent upon the same cause. Size has very little to do with it: a very large varicocele may coexist with a well-developed testis; but, as the testis is frequently ill-formed, soft, and flabby, and as it increases in size and firmness after operation, it is clear that the enlargement of the veins must help to perpetuate the condition, though it may not originate it. Where one testicle only is affected, there is no means of judging of the effect upon the seminal secretion; but there is reason to believe that sometimes at least, when both are, it is defective, and only becomes active when the testes assume their normal size and consistence.

**Treatment.**—In the vast majority, radical measures are entirely out of place; varicocele seldom causes inconvenience after early manhood is past. A suspender should be worn, one that is not too hot or complicated; the parts should be bathed with cold water night and morning; the bowels opened regularly; a fair amount of exercise taken, and stimulants, sexual excitement, etc., avoided. It is only when the health is out of order that the weight of the part is noticed. Occasionally, however, this is not sufficient; the patient may wish to

enter one of the Services; both sides may be involved; the varicocele may be serious from its size, the rapidity of its enlargement, or the danger of rupture or phlebitis (which is not uncommon in connection with gout); the testis may be irritable and tender, or the patient very much troubled about its condition. In those cases in which there is any reason to fear the development of hypochondriasis, every endeavor must be made to divert the patient's attention from the subject; but too often the attempt ends in complete failure, and, though the prospect is not an inviting one, there is no alternative. Pearce Gould considers operation advisable in all cases in which varicocele develops before puberty.

**Operation.**—The older method, in which a ligature was passed round the veins subcutaneously in one or more places, is practically abandoned: the result is uncertain, and there is great risk of transfixing a vessel. Even the addition of subcutaneous section does not increase the security. The method ordinarily adopted is to expose the veins freely, so that the structures to be dealt with can be seen; isolate the vas deferens with the spermatic artery, ligature the vessels above and below, and excise the intermediate portion. Pearce Gould, however, considers subcutaneous section with the cautery preferable.

The patient is placed under an anæsthetic, the parts shaved and cleansed, and an incision of sufficient length made along the cord, exposing the fascia which surrounds the veins. The vas is then carefully separated at the back, taking care not to isolate it, but to leave the fascia around it untouched; a catgut ligature passed round the rest of the fascia and the veins above, a second below, and the intervening portion excised. Practically, if the separation is commenced above, all the veins are included but one or two little ones with the vas. The length to be excised depends, as Bennett has shown, upon the height to which it is wished to raise the testicle, and after excision the two cut ends should be sutured together, so that the shortening of the fascia may help to support the gland. No drainage tube is needed, unless there has been much handling. The swelling afterward is considerable, and the testis may be a little tender, but I have never known orchitis follow. An ice-bag may be applied for forty-eight hours as a precaution. The patient should remain in bed for ten days or a fortnight, by which time the induration will have disappeared, and should wear a suspender for some months.

## HYDROCELE.

Hydrocele is a general term for a collection of serous fluid in connection with the testis or its coverings. It may be developed from the tunica vaginalis, or from the testis or epididymis; occasionally, both occur together.

### 1. *Hydrocele Developed from the Tunica Vaginalis.*

Of these there are various kinds, according to the part in which the fluid collects; the common example is hydrocele into the tunica vaginalis propria testis. It may be acute or chronic.

*Acute hydrocele* is usually secondary to inflammation of the testis or epididymis, but it may be caused by direct irritation of the tunica vaginalis. Its symptoms and treatment present nothing special: it may subside, leaving the sac more or less obliterated, or become chronic, or suppurate and form an abscess in front of the testis.

*Chronic hydrocele*, too, may be secondary; and occasionally it is associated with the presence of a pedunculated growth in the interior of the sac, or with elephantiasis; but in the majority there is very little evidence of irritation or inflammation. It occurs either in infancy or in commencing old age, when the functional activity of the gland is on the decline. In the former case, it is probably originated by the changes that attend the descent of the testis, and kept up by the tension; the cause, at any rate, is not persistent, for the hydrocele, once emptied, seldom returns; in the latter, it is more likely that there is some slight

irritant, possibly constitutional, for the fluid nearly always collects again if it is removed, and both sides are often affected. At other times of life, hydrocele, for such a common affection, is decidedly rare.

**Symptoms.**—Chronic vaginal hydrocele forms a smooth, ovoid, or pear-shaped swelling, more or less tense, completely concealing the testicle. There is no impulse on coughing, the cord above it is distinct, and the inguinal canal free. It begins below, slowly extends upward, and may reach an enormous size; fluctuation is distinct (unless it is too tense), and in the vast majority of cases the swelling is translucent. There is no pain or tenderness, merely a sense of dragging on the loins, owing to its weight; but if firm pressure is made behind, on the lower part, testicular sensation is usually felt. It is absolutely essential to make out the position of the testis (it may have been inverted in its descent, so that it lies in front, or dragged in various directions by old adhesions), but this may be done with much less discomfort to the patient by examining the swelling with transmitted light. The patient should stand upright, with a light held on the side on which the hydrocele is; the back part of the scrotum and the other testicle should be grasped with the left hand and drawn down, so as to make the skin as tense as possible, and the light shaded off with the right, which at the same time keeps the penis out of the way. The red glare can be recognized at once, the testis appearing as a dark shadow. If there is any difficulty, a roll of paper may be used as a tube to keep off outer rays.

Variations are not uncommon. Hernia or encysted hydrocele may be present. The shape may be complicated, owing to adhesions or sacculi; the fluid may have accumulated rapidly, with severe pain; translucency may be lost, owing to the addition of blood, and the walls may have become thickened from chronic inflammation. Old hydroceles are especially deceptive; they are often perfectly globular, like a hæmatocele, or malignant tumor of the testis; the walls are half an inch or more in thickness, with calcareous plates inside them, and the contents are milky and semi-solid with fatty matter and cholesterin; they are perfectly opaque; there is no sense of fluctuation, and, even if they are tapped, it is difficult to get a sufficient amount of fluid out of them for purposes of diagnosis. Practically, they can only be distinguished by their history, or by exploration.

**Diagnosis.**—*Hernia.*—Unless it is strangulated, there is always an impulse on coughing; a hernia is never translucent, and the swelling always extends through the abdominal ring. An irreducible epiplocele associated with hydrocele may cause some difficulty, but, if the swelling is grasped between the finger and thumb while the patient coughs, the impulse can be felt in one part and not in the other.

*Hæmatocele* and *tumors of the testis* are never translucent. Old hydroceles are, it is true, not translucent either, but in all of these exploration is essential.

*Inflammatory Affections of the Testis.*—Acute inflammation cannot easily be mistaken; chronic orchitis, on the other hand, attended with hydrocele (hydrosarcocele) may be very difficult: the fluid invests the testis completely, and the state of the gland cannot be ascertained until this is withdrawn.

The other forms of hydrocele into the tunica vaginalis are associated with congenital defects.

(*a*) In *congenital hydrocele*, the tunica vaginalis still communicates with the abdominal cavity. This is more common on the right side than the left, and usually occurs in children, although it may be met with at any age. It is distinguished by the swelling disappearing when the patient lies down and the sac is gently manipulated (some care is required, as the neck is usually long and tortuous); by an impulse on coughing (when the communication is sufficiently free); and by the variations in its size. It may or may not be associated with congenital inguinal hernia; the pressure of a truss is usually sufficient to procure obliteration of the neck.

(*b*) In *infantile hydrocele*, the communication is shut off in the inguinal canal, but nowhere else, so that when the sac is distended it forms a pear-shaped swelling, the smaller end of which extends up to and sometimes into the external abdominal

ring. Old hydroceles of the tunica vaginalis testis occasionally irritate this, owing to the yielding of the upper part of the sac. It occurs in infants, but is by no means confined to them, and requires the same treatment as the ordinary form.

(*c*) In *encysted hydrocele of the cord* the communication is shut off in the normal manner above and below, but the intermediate (funicular) part of the serous sac is not obliterated. It may form a sausage-shaped swelling in the cord in front of the vas; or a chain of separate rounded cysts, or a single one; and it may be immediately above the testis, so as almost to seem part of it, or in the inguinal canal, simulating a bubonocele. It is always translucent (when large enough) and tense, and it is distinguished at once by its moving with the cord.

2. *Hydrocele Developed in Connection with the Testis or Epididymis.*

*Encysted Hydrocele of the Testis.*—Small cysts may be formed in the tunica albuginea, or late in life in the epididymis, but these are of no surgical importance; the former are very rare, the latter scarcely admit of recognition. A different kind is occasionally found attached to the epididymis, developed in all probability from a rudiment of the non-sexual part of the Wolffian body, and corresponding, therefore, to the parovarian cysts in the female. Usually it is single, and of no great size; but it may be multiple, or it may reach along the cord and simulate encysted

FIG. 495.—Encysted Hydrocele of the Cord.

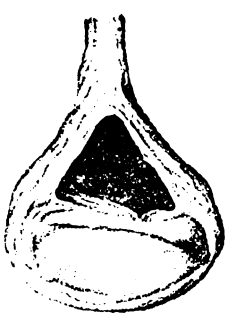


FIG. 496.—Spermatocele.

hydrocele developed from the tunica vaginalis. When small its contents are clear and albuminous, effervescing with acetic acid, from the presence of alkaline carbonates. As it grows larger, and presses upon the neighboring tubules, these not unfrequently rupture into it, so that it becomes filled with spermatozoa. Sometimes these are still living when the cyst is tapped; more frequently they are dead and motionless, but their presence is almost certain when the contents on their exit are milky white and opaque (*spermatocele*). Occasionally cysts of this kind are associated with the common form, and sometimes the partition wall becomes so thin that a communication forms at last.

**Treatment.**—Congenital hydrocele, whenever it appears, is a prolongation of the peritoneal cavity, and must be treated as such; a truss may be applied, and if this does not succeed the neck may be ligatured.

Hydrocele (other than congenital), occurring in infancy, usually gets well of itself. If it does not, lead lotion may be applied; or the swelling may be pricked (acupuncture) or tapped. Very few require anything more.

Later in life, if the tumor is of any size, it should be tapped. Occasionally it does not refill: much more frequently the fluid collects again, and if it is tapped a second time comes back more quickly than before. Whether the patient should rest content with temporary relief of this character, or undergo what is known as the "radical cure," must depend upon his age, the state of his health, his occu-

pation, and the amount of inconvenience he suffers. The operation is not a serious one in itself; but it may not be worth his while.

*Tapping.*—An ordinary trocar and cannula of small calibre is used, taking care that it is thoroughly clean and well oiled. The patient should be seated on the edge of a chair, with the knees separated, and the position of the testicle ascertained. The scrotum is grasped from behind with the left hand, so as to stretch the skin tensely over the swelling, and a spot selected on the front (in all ordinary cases), between some of the large scrotal veins. The trocar is held in the right, the

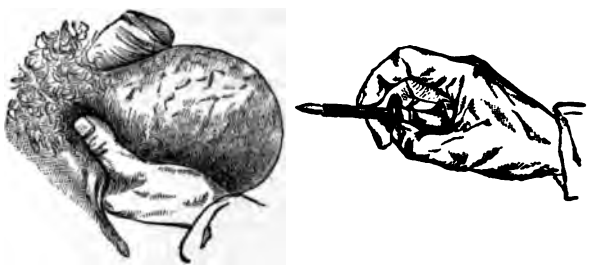


FIG. 497.—Tapping a Hydrocele.

thumb or forefinger being placed on it about half an inch from the point, so as to limit the amount of penetration, and entrance effected with a quick and firm thrust. As soon as the point of the instrument is in the cavity, the hand should be dropped so as to direct it upward away from the testicle. The whole of the fluid should be removed and the little puncture covered with some dry lint. The patient should wear a suspender afterward until the dartos has recovered.

*Acupuncture*, piercing the sac with a harelip-needle, and freely scarifying the interior, is chiefly suited to encysted hydrocele and the forms that occur in infancy.

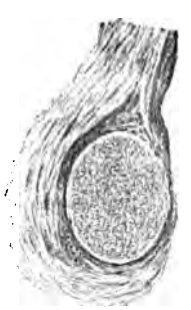


FIG. 498.—Obliteration of the Tunica Vaginalis after injection with tincture of iodine.

FIG. 499.—Tapping the Hydrocele. (*After v. Volkmann.*)

*Injection.*—Tincture of iodine (℥ss, pure, or with an equal quantity of water) is commonly used. The sac is emptied thoroughly, the fluid injected through a glass syringe (taking care that none enters the cellular tissue), and then, after being manipulated so as to bring it into contact with every part of the interior, allowed to escape again. Subacute inflammation at once sets in, with in many cases very severe pain, confining the patient to bed for some days. The skin becomes red; the sac refills; and even the testis may be affected. At the end of a week this

should begin to subside, and in a fortnight the whole should have disappeared, and the sac should have resumed its normal size, merely leaving a little thickening at the back of the testis. Occasionally, even when cure is permanent, no visible change is produced in the sac; more often a few adhesions form; and sometimes the sac is completely obliterated (Fig. 498). Failure occurs in at least one-third.

Carbolic acid (♏ xx, with glycerine), corrosive sublimate (.001), and iodoform may be used instead of iodine. The pain is less severe; if the sac is a small one, it is not necessary to confine the patient to bed, and the results are as good.

This method is chiefly suited to small hydroceles of the tunica vaginalis that have not been tapped many times: it should not be employed if there is any reason to suspect chronic orchitis; if the walls of the sac are thick; if the size is large; or if the patient is old and broken down in health.

*Incision.*—The tunica vaginalis is laid open; the edges sutured to the skin; and a drainage tube passed down to the bottom. This plan (using Lister's dressings) was introduced by Volkmann with the view of procuring direct union; but it is uncertain; it necessitates confinement to bed; and sometimes it leaves a persistent sinus.

*Partial incision*, removing the parietal portion of the sac, is much more satisfactory. A free incision is made down to the tunica vaginalis, the sac emptied, and as much as is thought desirable cut away with scissors, avoiding large veins and leaving the covering of the epididymis and cord. No vessels require ligature; the wound is sewn up; a drain is inserted; and the dressings arranged so as to obliterate the cavity and ensure primary union. If enough is removed the sac cannot refill; there is no pain afterward, and one change of dressings is usually sufficient.

In old hydroceles with thickened walls this is the only method; but in many of these the patients are already aged and broken down; the tissues are badly nourished and prone to slough; the testis can hardly be isolated without bruising; and it is a question whether castration is not preferable. The risk is certainly less.

## HÆMATOCELE.

By this is understood an effusion of blood into the tunica vaginalis or a cyst of the epididymis or testis. In addition, a form of diffuse hæmatoma has been described in connection with the spermatic cord.

(*a*) Hæmatocele into the tunica vaginalis propria testis is the usual form; all others are very rare. It is always the result of injury—blows, strains, the sudden emptying of a hydrocele sac reducing the pressure upon the vessels, or the puncture of a vein in tapping a hydrocele; but, for various reasons, it is very much more likely to occur when there is a pre-existing hydrocele than when the structures are sound and healthy. Its contents may be pure blood, or a mixture of blood and serum; coagulation usually follows, and after a time the clot breaks down, forming a turbid, chocolate-colored fluid, which becomes lighter and redder when exposed to the air. At first the sac itself is but little changed, but as time passes the walls become thickened, partly from the deposit of lymph around, partly from the deposit of fibrin mixed with ordinary coagula (almost as in an aneurysm) in the interior, until at length the testis is completely buried, and all sense of fluctuation is lost.

Hæmatocele developed suddenly in a previously healthy sac is usually globular; when it follows a hydrocele the shape depends on this. In either case it forms a smooth, tense, and elastic swelling perfectly opaque, concealing the testicle and not involving the cord. Fluctuation is rarely distinct; at first the sac is too tense; later, the blood coagulates and the walls become thickened. Signs of bruising and extravasation may be present for a time; and inflammation may follow, and even run on to suppuration; but the chief distinguishing feature is the rapidity of its formation.

The **diagnosis** must be made from tumors of the testis and old cases of hy-

drocele with thickened walls. In the absence of history that can be relied upon, exploratory incision is necessary.

(*b*) Hæmatocele into the funicular portion of the tunica vaginalis is very rare, and can only be diagnosed from encysted hydrocele of the cord by the history and the opacity of the swelling.

(*c*) Hæmatocele of the testis or epididymis must be distinguished from the corresponding form of hydrocele in the same way.

**Treatment.**—If the case is seen at once, an attempt must be made to limit the extravasation by means of cold, rest, and pressure. Afterward, when there is no fear of further hemorrhage, the size of the swelling should be reduced by tapping, and strapping applied, in the hope of causing absorption of the more solid portion. If this fails, or if the case is not seen until it has already lasted some time, an exploratory incision should be carefully made into the front of the swelling (the position of the vas deferens will usually give a clue to the relation the sac bears to the testis), the contents turned out, and all the fibrin dissected off. As this operation is a very tedious one, likely to be followed by extensive sloughing (the vitality of the sac and of the layers that line it is very low) and exposes the testis to considerable danger, the question arises, as in the case of old hydroceles, whether castration is not better for the patient.

# CHAPTER XXV.

## *DISEASES OF THE FEMALE GENERATIVE ORGANS.*

By J. A. Mansell Moullin, M. B., M. R. C. P.

### Inflammation of the Ovaries and Fallopian Tubes.

Inflammation of the Fallopian tubes may be acute or chronic. It rarely occurs as a primary affection; nearly always it is due to extension from the lining membrane of the uterus, sometimes from the ovaries.

**Causes.**—Gonorrhœa, inflammation after labor or miscarriage, the application of caustics to the interior of the uterus, anything, in short, that is liable to set up endometritis may cause it. The chronic form is usually associated with degenerative changes, cystic or cirrhotic, of the ovaries; but it is uncertain what relation these affections bear to each other.

**Pathological Appearances.**—In acute cases the tube is swollen, softened and engorged with blood, its inner surface covered with a flocculent muco-purulent fluid. Being loosely attached to the upper border of the broad ligament, it tends,

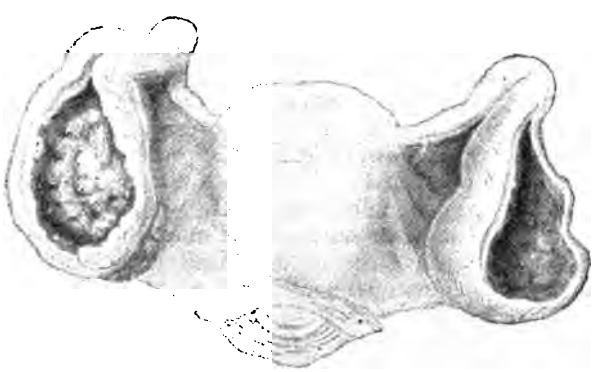


Fig. 500.—Inflammation of the Fallopian Tubes; saccular dilatation laid open.

by its weight, to sink lower in the pelvis, partially covering over the ovary. The surrounding peritoneum becomes inflamed and covered with lymph, glueing adjacent organs together.

In long-standing cases, especially those in which the acute attacks have recurred, the parts become utterly disorganized and indistinguishable. At an early stage the fimbriæ become glued, by adhesive peritonitis, to each other, or to the ovary, or to some neighboring part, and the outer opening is thus sealed. The secretion may find an exit through the urine opening, but in many instances this also becomes occluded, either by some valvular fold or the contraction of the inflammatory deposit in its walls. The tube thus becomes enormously distended by the retained secretion, forming a cyst containing several ounces, and presenting a more or less convoluted and pyriform shape. According to the character of the fluid distending the tube, it is known by the names of *hydro-*, *pyo-*, *or hæmato-salpinx*.

**Symptoms**, in recent cases, are those of peritonitis. In the chronic form, which comes more frequently before our notice, the symptoms, apart from the history, are exceedingly vague. Pain is always present, a constant dull aching in

the inguinal regions, extending to the sacrum and down the thighs. It is much aggravated by locomotion, and only partially relieved by rest, the patient waking with it in the morning. Menorrhagia is very constant, and the pain which has been present all along is much intensified at the time of the catamenia. Dyspareunia and pain on defecation are almost always present. Sterility is the natural result of the tubes on both sides being simultaneously affected. A most characteristic symptom is the recurrence of local peritonitis, time after time, without a definite reason. In recent cases, while the pain is severe, all that can be made out is a certain degree of fullness in the broad ligament, with extreme tenderness and fixation of the uterus. Later, as the attack subsides, bimanual examination may reveal a fullness in the region of the tube; sometimes it forms a distinct rounded tumor with a clear sense of fluctuation; sometimes, according as distention is present or not, a rounded band like an adhesion. The distended tubes are often prolapsed into Douglas's pouch. Whether clear serous fluid or pus is present can only be conjectured.

**The Prognosis** is very grave. Even if nothing worse happens, the patient is reduced by constant suffering to the condition of a chronic invalid. General peritonitis may supervene at any time, from extension of the inflammation or rupture of the tube. Pelvic abscess may occur, and if by chance conception should take place, the puerperal state will be accompanied by the gravest dangers.

**Treatment.**—Acute inflammation must be treated as acute local peritonitis; it may subside, resolution and absorption taking place, or become chronic. In the latter case, if the pain continues or the attacks recur with severe local symptoms, the uterine appendages with the ovaries should be removed.

*Oöphorectomy. Removal of Uterine Appendages.*—The preparation of the patient is the same as for ovariotomy, and the incision in the linea alba made in a similar manner. It should begin three inches below the umbilicus and run downward for two inches and a half. The fundus of the uterus is felt for first and the broad ligament followed until the ovary is discovered. As soon as this is found and freed from adhesions, it is drawn up and the pedicle transfixed with a double ligature and tied. The ovary and tube are then cut away and the opposite side explored and treated according to circumstances.

If there are no adhesions, or merely recent ones, there is little difficulty, but in long-standing cases, when all the tissues around are matted together by adhesions, it may be impossible to distinguish one structure from another, or to free the ovary and tube sufficiently to bring them to the surface. The tubes should be ligatured as close to the cornu of the uterus as possible. The remaining steps of the operation are dealt with according to ordinary principles.

## Ectopic Gestation.

Ectopic gestation signifies the development of a fœtus elsewhere than in its normal situation in the cavity of the uterus. There are many varieties of this displacement, but probably they all arise in the first instance from arrest of the ovum in its passage along the Fallopian tube. Nothing is known as to its causation. A plausible explanation suggests that the normal ciliated epithelium lining the tube having been destroyed by antecedent inflammation there is nothing to prevent the entrance of spermatozoa into the tube, or check the natural tendency of the fertilized ovum to adhere to the first surface it meets.

It forms at first a spherical or ovoid swelling by the side of the uterus, which undergoes sympathetic hypertrophy and forms a decidua, as in normal pregnancy. About the eighth or tenth week of fœtal life the walls of the tube rupture at the site of the placental attachment.

It must be remembered that the Fallopian tube is held in place by a fold of peritoneum which, after passing round it, is united loosely to itself by cellular tissue, forming a meso-salpinx. There is thus a narrow strip of tube running in an axial direction along the line where the two layers meet without any covering of

peritoneum. As the tube becomes distended by the growing ovum, these layers tend to separate, and this uncovered surface to increase in width.

The site of the rupture, according to Tait, is the leading feature, not only of the future pathological changes, but of the clinical progress and treatment of the case. If the rupture occurs in the part covered by peritoneum, as it usually does, the patient is almost certain to die from hemorrhage unless prompt surgical assistance is at hand. If rupture occurs into the broad ligament, in many instances the ovum does not die, and the hemorrhage is controlled by the fact that the blood pours into a mass of cellular tissue. The development of the ovum may go on to full term in its new situation between the layers of the broad ligament, and be extra-peritoneal.

When the ovum is arrested in that part of the tube which opens into the uterus, the period of rupture is usually delayed. This variety of gestation has been termed "interstitial."

**Symptoms and Diagnosis.**—1. *Prior to Rupture.*—Usually there is a history of previous sterility of longer or shorter duration. Then, about four weeks after pregnancy has commenced, the patient begins to complain of constant pain in the lower abdomen, with, at frequent intervals, violent exacerbations, causing intense prostration. At the same time there is great tenderness all over the iliac and hypogastric regions. On examination, a small rounded tumor, exceedingly tender on pressure, is found by the side of the uterus. This indicates nothing more than distention of the tube, but if, in the course of a week, it enlarges considerably, the symptoms become of great significance. No ordinary pelvic tumor grows with such rapidity.

As time passes, the ordinary signs of pregnancy make their appearance, with, in addition, irregular uterine hemorrhage, the decidua coming away sometimes in shreds, sometimes whole, so as to simulate miscarriage. The uterus enlarges, but remains empty; the os is soft and patulous and the body displaced to one side.

2. *Rupture.*—This usually occurs during some slight effort. All of a sudden the patient is seized with the most intense pain; there is a sensation of something giving way inside, and collapse follows at once. Death may be almost immediate, or the patient may rally and peritonitis set in. In the latter case a second rupture, to which the patient generally succumbs, may be anticipated before very long.

3. *If rupture does not take place, or does not prove fatal,* the signs of pregnancy become more marked; a tumor develops in the abdomen, lying to the one side, with perhaps the uterus in front; the pain and colic become less severe; the fœtal heart can be heard and movements felt. If the case progresses to full term, labor pains set in, sometimes more than once, with a blood-stained discharge from the uterus, and the child dies, very often after a violent attack of convulsions.

After the death of the fœtus the tumor ceases to increase. Generally decomposition and suppuration set in, and, if the patient does not die from septic absorption or pyæmia, the debris generally makes its way out through the abdominal wall, or the intestine, vagina, or bladder. Sometimes the dead fœtus remains quiescent for years, and occasionally it becomes converted into a calcareous mass or into adipocere.

**Treatment.**—1. *Before rupture,* attempts have been made to arrest the development of the ovum by various means, including the electric current. One electrode is applied as near the cyst as possible in the vagina, the other to the abdominal wall, and an interrupted current passed through as strong as the patient can endure. Great success has been claimed for this proceeding, but it must be remembered that cases of mistaken diagnosis are not uncommon at this early stage, that the muscular contraction induced by the current may itself cause rupture, and that even when the ovum is killed all danger is by no means over. In comparison with this, abdominal section offers manifold advantages.

2. *At time of rupture*, the symptoms pointing to internal hemorrhage, the proper course to pursue is to open the abdomen, secure the broad ligament at once, to control the bleeding, remove the cyst, clear out the debris as thoroughly as possible, and drain the peritoneum. If the sac cannot be removed, it should be laid open, the fœtus extracted, and the walls stitched to the parietal peritoneum.

Interstitial gestation, unless the rupture takes place into the uterus, can only be treated by supra-vaginal hysterectomy.

3. *If the fœtus survives the period of rupture*, the question arises whether operation should be performed at once, or whether it should be postponed with the view of extracting a living child. It depends upon the risk the mother runs before and during the operation. Tait holds that it is not materially increased by delaying operation; but this view is not shared by others.

The patient is prepared in the same way as for ovariotomy, and the same incision is made. The fœtus may be found either free in the abdominal cavity, or enclosed within a sac. If the latter, the sac must be laid open, avoiding, if possible, the placental attachment, and the fœtus extracted. The sac itself is then removed, or, if this is impossible, the edges secured by suture to the parietal peritoneum and skin. The chief difficulty which presents itself to the surgeon is the management of the placenta. Opinions are divided as to whether it should be allowed to remain *in situ*, or an attempt made to remove it. It must be remembered that it is attached to the interior of a morbidly vascular cyst, and covers a large surface. An attempt to remove it may be followed by severe hemorrhage, and no contraction of the cyst can be expected to follow its expulsion, as is the case in normal pregnancy. The advantages of removing it are, however, so obvious that it should be extracted if possible. There may be no difficulty, and if the hemorrhage is very great it can generally be controlled with perchloride of iron. If it is impossible, the cord must be left hanging out of the abdominal incision, and a drainage tube passed into the cavity to keep it dry. It may be necessary to syringe out the cavity with some antiseptic, and in the event of any large portion of the placenta sloughing, to enlarge the opening to facilitate its removal.

Extraction through the vagina may possess certain advantages over the abdominal operation, if the fœtus can be felt presenting by the head or feet, and if the thinness of the structures separating the presenting part from the vaginal canal renders it certain that the placenta is not situated in that part of the sac.

In cases in which the fœtus is already dead no rules can be laid down. We must be guided by the general principles which direct the treatment of all abdominal tumors. If it is suppurating, an attempt must be made to open the abscess, evacuate the contents and drain the cavity with as little delay as possible.

## Tumors of the Ovary and Broad Ligament.

Tumors of the ovary may be divided broadly into two classes, cystic and solid.

*Solid tumors* are represented by fibroma or fibromyoma, sarcoma and carcinoma.

1. *Fibroma or fibromyoma* of the ovary is not very common, and is indistinguishable from fibroma of the uterus. Its growth is usually slow, but it sometimes attains a large size. Both organs are frequently affected at the same time. The tumors are hard, smooth externally, and on section present a perfectly homogeneous appearance. Under the microscope they are found to consist of fibrous tissue with a variable amount of non-striated muscular fibre.

2. *Sarcoma* is more frequently met with. It occurs as a primary affection and is often symmetrical. It grows with great rapidity, and is generally attended with ascites. Both the sarcomata and fibromata, occurring as they do in the free portion of the ovary, are usually pedunculated.

3. *Carcinoma* is almost invariably secondary to cystic disease of a non-malignant type. In all its forms it grows rapidly, and tends to invade the neighboring organs, which soon become matted together in an immovable and indistinguishable mass. Pain and ascites are invariably present, and the general condition of the patient fails very rapidly.

*Cystic tumors* occur with much greater frequency than the preceding. They present an infinite number of varieties, which may be grouped under three heads: "multilocular," "dermoid," and "papillary."

FIG. 501.—Multilocular Ovarian Cyst.

1. *Multilocular tumors* have their origin in the Graäfian follicles situated in the outer or free portion of the ovary—the oöphoron. On cutting into such a tumor, a mass of thin, but opaque-walled, secondary cysts, mixed with more or less solid growth, is seen projecting into the main cavity, and from the cysts when opened there escapes a glairy mucoid fluid, in some cases as tenacious as treacle.

The small cysts are lined with columnar epithelium of large size. In the larger ones it is more flattened or tessellated, in many parts dipping down to form mucous glands.

The more solid portions consist of young or embryonic connective tissue, crowded with spaces filled with mucus. These secondary cysts are indistinguishable from the retention cysts formed in mucous membranes, and, indeed, the solid masses are really adenomata on the type of mucous glands.

One cyst often predominates to such an extent that the tumor appears to be unilocular, but examination seldom fails to reveal secondary cysts projecting under the lining membrane, generally toward the site of attachment of the pedicle.

As multilocular cysts originate in the free part of the ovary, the paroöphoron or tissue of the hilum, as it is termed, remains unaffected, and such tumors are invariably pedunculated.

The Graäfian follicles are liable to other degenerative changes than those just described. In some instances they undergo simple dropsical distention, the cysts thus formed varying in size from a cherry to that of the fœtal head. The walls are thin, membranous, and translucent, identical in

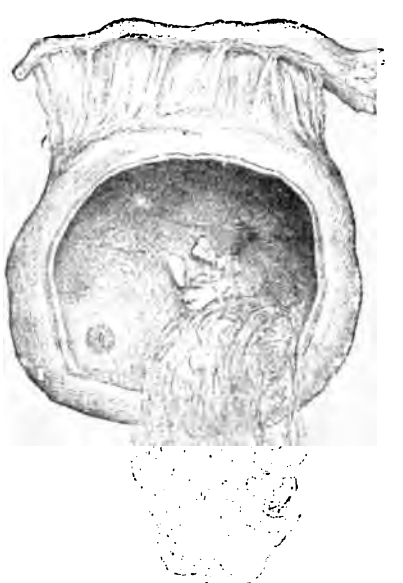


FIG. 502.—Dermoid Cyst of the Ovary, showing Hair, Teeth, and Nipple.

structure with those of the follicle. The contents are a clear, limpid fluid, with an ovum sometimes floating freely, sometimes attached to the epithelial lining, which is smooth and without projecting septa. Rokitansky first described this condition.

2. *Dermoid cysts* of the ovary, according to Sutton, are simply a highly organized form of the common multilocular, glandular cyst, and like it have their origin in the Graäfian follicles.

The walls of a dermoid cyst resemble in every respect true skin. The inner surface is lined with thick layers of squamous cells, becoming more rounded in the deeper strata. Beneath this is a layer corresponding to the cutis, and frequently presenting papillæ; deeper still are areolar tissue and fat containing hair follicles, sebaceous and sweat glands. Teeth, either perfect or rudimentary, are often present in large numbers, springing either from the cyst wall or from well-formed alveoli in bony plates. Sometimes even a mammary gland is found, presenting a nipple and capable of secreting a fluid. The contents of the cyst consist, in many instances, of a bright yellow liquid, composed of fat, cast-off epithelium, and cholesterin. At the temperature of the body it remains liquid, but very soon solidifies

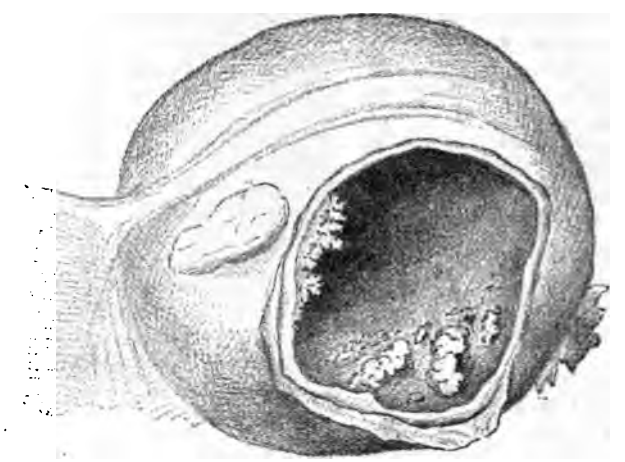


FIG. 503.—Papillary Cyst of the Ovary.

on cooling. In other cases the contents are of much the same color and appearance as gruel or putty. Mixed with this are often large masses of loose hair, generally of a pale color, and loose teeth.

At first sight nothing can present a greater contrast than a dermoid and a multilocular, glandular tumor. They, however, both take their origin in the same part of the ovary—the oöphoron—and they are frequently found associated. Careful examination of a multilocular tumor often discloses a small patch of dermoid tissue, and the presence of a few hairs. The great frequency with which dermoid tumors occur in the ovary would seem to prove a close connection with the production of Graäfian follicles; and if the membrana granulosa of the follicle is capable of forming mucous membrane and complex mucous glands, there is no reason why it should not form skin, which is practically identical with mucous membrane and its accompanying teeth and hair. All these transitional stages have been traced by Sutton.

3. *Papillary cysts* of the ovary have a totally different origin, and arise in the paroöphoron or tissue of the hilum. Multilocular tumors, arising in the free part of the ovary, are usually pedunculated; papillary cysts, on the other hand, arising in the hilum, are more usually sessile and tend to burrow between the layers of the

broad ligament, while the ovary more or less retains its shape or is flattened out upon the surface of the cyst.

The paroöphoron or tissue of the hilum is composed largely of fœtal elements. The vertical tubes of the parovarium converge toward its attached border, and can be traced through its substance sometimes even into the oöphoron. These tubes, in the perfect condition, are lined with ciliated epithelium. They have a tendency to morbid changes and to become cystic, the chief peculiarity of the cysts being the development of solid papillary or cauliflower growths from their inner surface. These growths are covered on the free surface with a layer of cylindrical epithelium, occasionally ciliated and bleeding readily when handled during operation. They have a tendency to burst through their cyst walls and then spread over and infect the neighboring organs. The secondary deposits often exhibit the same character, and the pelvis has been found filled with masses of thin-walled cysts studded with numbers of outgrowths. Cysts of this kind invariably contain a thin fluid, quite different from the mucous contents of the multilocular tumors, and often stained with blood.

The occurrence of mixed multilocular and papillary tumors is readily explained by the fact that the fœtal elements are often found extending into the oöphoron.

The papillary growths have a further tendency to become malignant in character, but under what conditions is uncertain. The removal of a papillary tumor which has already infected the neighboring peritoneum has been followed by permanent cure, and the secondary growths have been ascertained by subsequent operation to have completely disappeared.

*Cysts of the broad ligaments* are either "simple" or "papillary."

*Simple* cysts may take their origin in any part of the broad ligament, and when of minute size are sometimes present in considerable numbers. Occasionally they are pedunculated, but more frequently they stand out from the surface without possessing a distinct pedicle. They are invariably unilocular, with thin walls lined with flattened epithelium, and contain a clear limpid fluid, with but little albumin. Their growth is very gradual, and they cause but slight peritoneal irritation, so that adhesions are rarely present. When pedunculated they cannot be distinguished from thin-walled ovarian cysts. When sessile, the tumor usually causes great lateral displacement of the uterus.

*Papillary* cysts are developed from the vertical tubes of the parovarium, and are identical in every respect with those formed from similar structures in the hilum of the ovary. They may increase in size with great rapidity, and should rupture occur, the papillary masses have the same tendency to sprout into the peritoneal cavity, and extend over the surface of the uterus and neighboring organs. Compared with the simple variety, these latter are not of very common occurrence. Papillary cysts are always sessile, and cannot, even when of large size, acquire a central position in the abdomen, like an ovarian cystoma. *Per vaginam*, the uterus is always found displaced to one side, and the sense of immobility is very plainly marked, but a certain diagnosis is impossible.

**Symptoms.**—1. *The Early Stages while the Tumor still Occupies the Pelvis.*—The symptoms in many cases are so slight that they escape notice altogether; in others there is a history of long-continued pelvic trouble and pain in the ovarian region. Menstruation is not necessarily affected, but as the disease advances there is a tendency for it to become more and more scanty. Conception may occur, even though both ovaries are more or less cystic. If the tumor falls into Douglas's pouch, it may give rise to symptoms of pressure upon neighboring organs.

On bi-manual examination a smooth, rounded, tense body can be felt, stretching the roof the vagina on one side of the cervix, or a little behind. If there is a distinct groove or furrow between it and the uterus, and if it is movable, so that it can be easily lifted out of the pelvis, it is tolerably certain to be a small cyst of the ovary. The chief difficulty in diagnosis occurs in connection with dropsy of the Fallopian tube. The latter condition may usually be distinguished by the

fact that it is in many cases symmetrical, and by the history, for it is usually preceded by prolonged pelvic trouble. Sometimes a small cyst suppurates (a frequent complication with dermoid tumors), and forms a swelling that, on vaginal examination, is painful, tense, fluctuating, and indistinguishable from a pelvic abscess.

2. *After the Early Stage is past, when the Tumor rises up into the Abdomen.*—(1) *Obesity* may give rise to the suspicion of ovarian tumor, especially if it is associated with loss of tone in the intestinal wall, so that the abdomen becomes immensely distended with flatus and fæces. The indications of general obesity: the soft flaccid condition of the abdominal wall when the patient lies down; the absence of any tumor on palpation; and the sinking of the two recti below the general level, when the patient endeavors to raise herself, are sufficient to dispel any doubt.

(2) *Pregnancy, when the Uterus has begun to rise out of the Pelvis.*—Ordinarily speaking, the diagnosis can be made at once from the mammary changes, the placental bruit, fœtal cardiac sounds, fœtal movements, ballottement, softening of the cervix, blueness of the vagina, etc.; but in exceptional cases, there may be some difficulty. The two, for example, may occur together. This may be suspected when, with a history of pregnancy, vaginal examination shows the uterus to be elevated, with the cervix high above the pubic symphysis, and an obscurely fluctuating mass lying behind it; or when the abdominal distention is greater than the period of gestation would account for. At a later period, the abdomen may be distended laterally and asymmetrically, with a sulcus separating the two tumors.

(3) *Hydramnios.*—This may easily be mistaken, as the distention is out of all proportion to the period of pregnancy; and the walls of the uterus are so thin that fluctuation can be felt, just as in an ovarian cyst. The cervix, however, is soft, as in pregnancy, and it is spread over and evidently continuous with the tumor. The sound may be used to decide the question.

(4) *Abdominal Pregnancy.*—The symptoms of pregnancy are present, but the position of the tumor corresponds more nearly with that of an ovarian cyst. If the outline of the child can be felt, or its movements seen, while the uterus remains soft and empty, there is no difficulty; but, in old-standing cases, unless the history is very clear, a positive diagnosis may be out of the question.

(5) *Ascites, especially with Thin-walled Unilocular Cysts.*—The most important diagnostic sign is the relative position of the intestines and the tumors. In ascites there is resonance in front and dullness in the flanks, and this varies with the position of the patient; again, in the recumbent position, the flanks bulge out and the belly becomes flatter. In ovarian disease this is reversed. In the erect position, the upper limit of the area of dullness is concave in ascites, convex if there is an ovarian tumor.

| OVARIAN CYST. | *v.* | ASCITES. |
|---|---|---|
| | *History.* | |
| General health good before discovery of enlargement, failing gradually since. | | Health fails before the swelling appears. |
| Often dysmenorrhœa. | | Nothing characteristic. |
| No organic disease. | | Disease of heart, liver, kidneys, or peritoneum. |
| Tumor, lateral at first, central later. | | Bulging at lower part of abdomen when standing. |
| Œdema of extremities late. | | Œdema early. |

| OVARIAN CYST. | *v.* | ASCITES. |
|---|---|---|

*Inspection.*

| | |
|---|---|
| Abdomen prominent, often irregular. Umbilicus never prominent or thinned. | Abdomen flat in front, bulging at the sides and evenly. Umbilicus often prominent and thinned. |
| Greatest circumference below umbilicus. | Greatest at umbilicus. |
| Facies ovariana not marked until late. | Often cachectic from the first. |

*Palpation.*

| | |
|---|---|
| Abdominal wall tense, and resists pressure. | Soft and lax, unless amount of fluid very great. |
| Fluctuation most distinct superficially in front. | Most distinct in flanks. |
| Aortic pulsation may be felt. | Never transmitted to the front. |
| Per vaginam, the cyst may be felt at the roof or in the cavity of the pelvis, partially displacing the uterus. | No cyst, a sense of bulging only. |

*Percussion.*

| | |
|---|---|
| Dullness in front; flanks resonant. | Resonant in front, flanks dull. |
| In erect position, line of dullness convex. | In erect position, concave. |
| Dullness not altered by change of position. | Varies according to position. |

*Character of Fluid.*

| | |
|---|---|
| Fluid viscid, sticky, sp. gr. 1018–1024. | Limpid, sp. gr. 1010–1015. |
| Varies in color. | Light straw-yellow. |

Difficulties may arise from:—

(*a*) The absence of mesocolon, so that the flanks are resonant.

(*b*) The small intestine being tied down by adhesions, so that the front of the abdomen is dull.

(*c*) The fluid being encysted, as in old tubercular peritonitis.

(*d*) Carcinoma of the peritoneum, but usually rough nodules can be felt.

(*e*) Both may be present, and then the cyst may be felt sometimes by suddenly depressing the front wall with the fingers.

(6) *Hydatids of the Liver or Omentum.*—The enlargement usually takes place from above. The pelvis is free; the uterus and ovaries normal, and there is a line of resonance between the tumor and the pubes. If the aspirator is used, the fluid is colorless, of low specific gravity, with no albumin, but some chloride of sodium.

(7) *Hydronephrosis.*—There is no difficulty when the tumor is small or varies in size concurrently with the passage of large quantities of urine. As the tumor enlarges and grows toward the centre and down into the pelvis, the diagnosis may be almost impossible. The relation of the intestine to the tumor (the colon lying on it, either as a band which rolls under the finger, or as a line of resonance, according to the distention), and the dullness reaching round in the flank quite to the spine, are the most important diagnostic points.

(8) *Uterine Tumors and Fibrocysts.*—These may usually be distinguished by the slowness of their growth, by their solidity, and by the fact that, apart from

menorrhagia, they do not impair the general health. The pelvis is more or less filled up by the uterine growth; the cervix is drawn up behind the symphysis, or otherwise displaced; bi-manual examination shows that it is continuous with the tumor; the length of the uterine cavity measured by the sound is greatly increased, and abdominal movement of the tumor is distinctly communicated to the sound *in utero*.

| OVARIAN CYSTIC DISEASE. | *v.* | UTERINE FIBROCYSTIC DISEASE. |
|---|---|---|
| May occur at any age. | | Rare before thirty. |
| General health suffers soon. | | Good, unless there is menorrhagia. |
| Emaciation. | | None. |
| Complexion pale, face pinched, "facies ovariana." | | Often florid, at other times the face is dull, dejected, and muddy. |
| Tumor lateral at first. | | Tumor generally central. |
| Growth rapid. | | Slow. |
| Surface, uniform, fluctuation distinct. | | Often lobulated; elastic, but fluctuation obscure. Cyst wall thick. |
| Uterine souffle never heard. | | Often present, resembling the placental bruit. |
| Uterus not enlarged. | | Elongated, and canal tortuous. |
| Tumor may be raised from the pelvis, or uterus can be moved independently of the tumor. | | Tumor continuous with uterus, and moves with it. |
| Fluid viscid, albuminous, clear or dark, not spontaneously coagulable. | | Fluid clear and limpid, not viscid; little albumin; yellow or muddy; coagulates spontaneously. |
| Menstruation not necessarily affected; may be dysmenorrhœa at first, and then suppression, but no menorrhagia. | | Profuse menorrhagia, unless tumor is subperitoneal. |

In spite of these differences, it may be impossible (without an exploratory incision) to distinguish an ovarian cyst from a soft, rapidly growing myoma, or from a fibrocyst connected with the uterus by a slender pedicle. A dermoid closely connected with the uterus much resembles a fibroid.

**Complications.**—*Adhesions.*—Adhesions are found not to interfere with recovery, unless they are so extensive as to prevent removal. Their absence may be presumed if there has been no peritonitis, and if the tumor and the uterus are both freely movable. Extensive adhesions, however, may connect it to the liver above, the intestines behind, and the pelvis below, without its being possible to determine beforehand their extent, or even their presence.

*Rupture of the Cyst.*—In the majority of instances this is mere leakage, and the fluid is absorbed at once with but slight discomfort. Traumatic rupture, however, may be followed by fatal hemorrhage or peritonitis.

It may be caused by simple thinning; or by degeneration from thrombosis; or by the formation of secondary cysts in the substance of the main wall, weakening it as they enlarge until it gives way.

When the leakage is slow, there may be no symptoms of peritoneal irritation at all. The tumor, if the loss is of any amount, diminishes in size; its tension falls, and the solid parts become more prominent. At the same time signs of fluid in the peritoneal cavity make their appearance, but there may be nothing to call attention to the accident.

When, on the other hand, the rupture is sudden and due to injury, there is the most intense shock, with, if the patient rallies, great danger from hemorrhage and, later, peritonitis.

Immediate operation is the only course. The peritoneal cavity may be filled

with the glairy, colloid contents of the cyst, or with blood clot. In either case this must be turned out, the pedicle secured, and the tumor removed in the usual way. The peritoneum must then be thoroughly cleansed with a stream of warm water. In the case of colloid cysts a certain amount of peritoneal irritation is generally present; when bathed for a long time in the colloid fluid, the membrane becomes thickened and injected, presenting an appearance like that of boiled sago. The removal of this material is a matter of great difficulty, as it clings with great tenacity to the intestines and abdominal organs; the most effectual method is repeated flushing with warm water, in which it is partly soluble.

*Twisting of the Pedicle.*—This is probably due to the tumor being pressed upon by the viscera above and the pelvic structures below, while it remains free laterally and anteriorly; each time the patient, lying on her back, rolls over on her side, it rotates a little, and if it does not return, or if there is any irregularity of shape assisting it, it may at last be carried too far to recover itself. An accumulation of fæces in the rectum can impart considerable rotation to the pelvic tumor.

If the twisting is complete, the symptoms are very characteristic. Pain, vomiting and shock come on with great severity; the tumor rapidly increases in size; peritonitis sets in, though without any great rise in temperature, and the patient's condition becomes very alarming. If, on the other hand, it is only partial, the symptoms are less sudden, but equally severe. More or less complete strangulation occurs, with intense venous congestion, hemorrhage into the cyst, and, later, peritonitis. Gangrene is rare, owing to the rapidity with which vascular adhesions develop and maintain the circulation. Sometimes the pedicle disappears, and the growth of the tumor depends on the new attachments formed in this way; exceptionally, the tumor itself atrophies.

Ovariotomy should be performed as soon as the shock has subsided. The cyst is generally found intensely black and filled with clotted blood, and the peritoneum everywhere covered with lymph and soft adhesions. If the loss of blood is not excessive, the prognosis is not unfavorable.

**Treatment.**—*Tapping.*—This can only be recommended for cases in which immediate relief is absolutely necessary and the condition of the patient too serious to admit of complete removal. It has been followed by hemorrhage, peritonitis, and by suppuration in the cyst, and is a proceeding to be avoided if possible. For purposes of diagnosis it is of little use.

*Ovariotomy.*—The time selected should be shortly after a menstrual period. An aperient is given the day before, and an enema the morning of the operation, to ensure that the bowels are fully relieved; and a catheter should be passed if there is any question as to the condition of the bladder. The extremities should be warmly clad, the shoulders slightly raised, and the abdomen protected with a waterproof sheet in which there is a central opening large enough to expose the skin from the pubes to a short distance above the umbilicus. The margin of this is covered on its under surface with adhesive plaster, to prevent any fluid escaping beneath.

The assistant stands on the patient's left, opposite the operator. A nurse is required, whose sole duty it shall be to attend to the sponges. All instruments, ligatures, etc., are to be kept immersed in a five per cent. solution of carbolic acid; and, like the sponges, they must all be counted, in order that none may accidentally be left in the abdominal cavity.

Special instruments required are: twelve small pressure-forceps; two cyst trocars, large and small, either Well's or Tait's, with tubing; four large cyst forceps, angular and straight; two pedicle needles, in handles, blunt; and six sponge holders. Six of Keith's glass drainage tubes of various sizes should be at hand.

The incision is from two to three inches in length, according to the thickness of the abdominal walls, midway between the umbilicus and the pubes; and planned to hit off the division between the recti. As soon as the peritoneum is exposed,

it is picked up with a pair of forceps and carefully opened. Unless adhesions are present, the bowels fall away as the air is admitted, so that there is no danger of their being wounded. Considerable difficulty, however, may be experienced if the peritoneum is thickened and vascular from old attacks of inflammation, or adherent to the front of the tumor; the sub-peritoneal areolar tissue may be mistaken for intra-peritoneal adhesions, and the serous membrane stripped away from the transversalis fascia. If there is the least doubt, it is always advisable to prolong the incision upward, until a space that is certainly free from adhesions is reached.

If the length is not sufficient the incision may be extended downward to the pubes (care being taken not to wound the bladder) or upward, toward or even beyond the umbilicus, passing either through it or round to the left side.

As soon as the tumor is exposed and its general character and relation ascertained, the size should be reduced as far as possible by emptying it of its contents. Simple cysts may be tapped at once, the trocar being driven smartly in while the tumor is steadied and pressed somewhat forward by the assistant, so that none of the fluid enters the abdominal cavity. Multiple cysts may be treated in the same manner, the trocar, without being withdrawn, being driven through one to the other until all the larger cysts are emptied. If the contents are too viscid to flow through the cannula, it should be withdrawn, the opening enlarged, the septa thoroughly broken down, and the debris scooped out with one hand while the walls are drawn forward by means of forceps with the other, the assistant meanwhile keeping up steady pressure upon the sides of the abdomen, and preventing the escape of the intestines by the side of the tumor.

As the cyst diminishes in size and is gradually drawn out through the abdominal opening, any adhesions that may be present come into view. Recent ones may be easily separated by the pressure of a sponge; older ones are better secured with a ligature. For obvious reasons it is not advisable to leave forceps attached inside the abdominal cavity. If the cyst is so firmly attached to the bowel that it cannot be separated, the adherent portion of the wall should be cut off and left *in situ*. Sessile tumors burrowing between the layers of the broad layers must be enucleated. Commencing near the uterus, the peritoneal investment is carefully stripped off the tumor, keeping as close to the cyst wall as possible. The flaps of the broad ligament are then sewn together, or ligatured, or, if the cavity be very deep, sewn to the abdominal incision and a drainage tube inserted.

The pedicle is secured with a silk ligature, and returned into the abdominal cavity. If it is too large to be embraced in one loop, it may be transfixed and tied in two halves with a figure-of-eight ligature; or Lawson Tait's Staffordshire knot may be employed. An ordinary handled needle, threaded with a long piece of silk, is passed through the pedicle and withdrawn, leaving a loop on the distal side. This is drawn over the tumor, and one of the free ends passed through it, so that one is above and the other below the loop. The pedicle is then fixed with the finger and thumb of the left hand, and the two ends of the ligature drawn as tightly as possible, and secured by means of an ordinary knot. The thinnest portion of the pedicle should always be selected, and if it is very bulky it may be reduced in size beforehand, by clamping it temporarily with a pair of strong forceps. If there is the least doubt as to its being properly secured, a pair of catch-forceps should be fastened to it, so that it may be drawn up and inspected the last thing before the wound is closed.

Finally, the other ovary should be examined, taking care not to make too much traction upon the uterus for fear of disturbing the ligature already applied.

The abdominal cavity should be thoroughly cleansed from all clots and foreign material, warm dry sponges being carried down into the loins and Douglas's pouch for the purpose. If any of the contents of the cyst have escaped, thorough irrigation with hot water is preferable; it is more efficient and does less harm. Drainage should be adopted in cases of enucleation, and where, owing to the depth in the pelvis or extent of the adhesions, it is difficult to see and control the hemorrhage. The tube should be sufficiently long to reach to the bottom of Douglas' pouch with-

out pressing upon the rectum. There is a small collar at the upper extremity, which rests upon the edges of the wound at the lower angle, and it is perforated at the sides with several small openings, so that fluid may find its way in, and be removed as required by means of a syringe.

A flat sponge is placed upon the surface of the intestines, while the sutures are being passed. Silk or silkworm gut is the best material for the purpose ; all the layers of the wall must be transfixed ; and the sutures placed sufficiently close to ensure thorough adaptation of the peritoneal surfaces. The sponge is withdrawn when they are all in position and tied, except the last one or two. Absorbent dressings are laid over the wound of sufficient thickness to fill up the natural hollows of the abdomen ; and, if a drainage tube is used, to protect it from pressure ; and over all a many-tailed bandage is applied. Then the patient is carefully lifted up from the table to a well-warmed bed placed by its side.

The thin wall of a broad ligament cyst presents a characteristic appearance, differing greatly from the shining, opaque, and silvery-white surface of an ovarian cystoma. When pedunculated it can easily be secured with a ligature. The Fallopian tube and ovary are frequently flattened out over the cyst, and need not necessarily be removed with the tumor ; but it is better to remove them than to complicate the operation by attempting to separate them. When sessile the cyst burrows deeply between the layers of the broad ligament. In such cases it is necessary to reflect the peritoneum from the surface of the cyst and carefully enucleate it. Care must be taken not to injure the uterine artery, which forms a loop with its concavity upward close to the neck of the uterus, and the ureter, which runs across beneath the base of the broad ligament to its insertion in the bladder. The flaps of the broad ligament may be united by sutures or treated as a pedicle and partly cut away, according to circumstances.

**After-treatment.**—For the first twenty-four hours it is better to give nothing but small quantities of hot water or hot toast water. The second day the patient may take a little arrowroot or beef tea. An irritable condition of the stomach is frequently a troublesome complication. Drugs are of little use. If the retching is severe, a tumblerful of warm water will often help the patient to bring up a large quantity of mucus, and relieve the symptoms. Should it fail, the administration of all nourishment by the mouth must be discontinued, and the patient supported by nutrient enemata. In the case of feeble subjects this may be done at once with advantage. Peptonized beef tea is the best when it can be procured : three ounces should be injected into the rectum about every four hours. Before giving an enema the rectal tube must be passed two or three inches into the rectum, and allowed to remain there for a few minutes, to permit the escape of flatus and any fæcal matter which may be present.

The administration of an opiate after the operation is not necessary unless there is pain. Many patients are very intolerant of the drug. It is especially deleterious in those cases in which the urine is scanty, slightly albuminous, and of low specific gravity. When required it may be given in the beef-tea enemata.

If the bowels have not acted spontaneously, measures should be taken to procure an evacuation by the evening of the fifth day. An enema of four ounces of warm olive oil may be injected, and, four hours later, a pint and a half of soap and water. As a rule, an action speedily follows ; if not, the enema must be repeated. A gentle purgative does no harm ; on the contrary, when the appetite is lost and the tongue thickly furred, it is certainly beneficial. A drachm of compound liquorice powder or some other laxative may be given with the preliminary olive oil enema.

The catheter need not be passed until the patient asks to be relieved. Afterward it will be required three times daily for the next two or three days, but the use of the instrument should be discontinued as soon as possible. The majority of patients can pass their urine voluntarily after the first forty-eight hours, but in some cases the want of power continues for several days.

A wat ble, especially for aged patients. Every care in such

cases must be taken to avoid the occurrence of a bed-sore; the patient must not be strictly confined to her back, but be allowed to change her position from time to time and lie on her side. The catheter should be avoided altogether, if possible.

The dressings need not be touched until the eighth day. By that time the wound should be united and the sutures may be removed. The wound should then be washed, carefully dressed with carbolic gauze, and supported with strapping. The patient must not be allowed to get up under a fortnight, and meantime should be provided with a well-fitting abdominal belt. It must not be forgotten that the cicatrix may stretch and form a hernial sac into which a large mass of intestines and omentum may obtrude itself, to the great discomfort of the patient. To obviate this it is necessary to protect the cicatrix carefully long after convalescence.

**Complications.**—*Shock.*—The shock may be severe, especially if the operation is prolonged. Warm blankets, hot-water bottles, etc., must be used freely to keep up the temperature, and a little brandy or ether and sal volatile may be given as soon as the patient can swallow.

*Rise of Temperature.*—In about twenty-four or thirty-six hours after the operation the temperature usually reaches its highest point. In many cases this is not above 100°, but a considerable rise of temperature at this time is not of any serious import. If it rises above 102°, with a concomitant rise of pulse, the application of the ice-cap will reduce it.

*Secondary hemorrhage* may arise from the pedicle slipping out of the ligature. It is very important, when securing it, not to exercise too much traction on the pedicle; the outer border is liable to retract and slip out, and the ovarian artery thus set free bleeds freely. If there is any fear of this, the ovarian vessels in the outer border should be secured separately. The splitting of the pedicle may also be a cause of secondary hemorrhage; this is liable to occur if it is transfixed and tied without the threads having been properly crossed, the two halves of the pedicle being pulled asunder. Secondary hemorrhage may also occur from vessels in adhesions.

The symptoms of internal hemorrhage are characteristic and usually come on within a few hours after the operation. The patient becomes faint and blanched, and the pulse small and rapid. There must be no hesitation: the only course open is to place the patient under an anæsthetic, re-open the wound, and find and secure the bleeding point.

*Peritonitis and septicæmia* may come on from the second to the fourth day. The earlier symptoms are very insidious, but the following combination is sufficiently grave. The vomiting which most patients suffer from for a few hours, and is probably due to the anæsthetic, instead of subsiding, persists. At first it is white and frothy, but, subsequently green or dark; the pulse increases in frequency, at the same time decreasing in force; the respirations are more frequent; the face becomes pallid or slightly jaundiced, the mental condition depressed; the tongue is red, rough, and dry, though, like the skin, it sometimes remains moist throughout; the abdomen becomes tympanitic and tender, and no flatus is passed. The temperature in many cases continues low from the first, and does not afford any characteristic indication.

The **prognosis** is most unfavorable. When the symptoms are those of general peritonitis, active treatment is of little avail. When they point to the formation of an abscess in the pelvis, or in the abdominal walls around the wound, there is more hope.

The stomach may be washed out with warm water every six or twelve hours, if the vomit be dark and bilious, until it ceases. The passage of the rectum tube may enable the flatus to escape and relieve somewhat the abdominal distention. Beef-tea enemata must be administered every three or four hours.

*Intestinal obstruction* is a complication that occasionally follows ovariotomy. It may be caused in various ways—by the intestine becoming adherent to the ab-

dominal incision or other raw surface, or by its becoming entangled in the omentum. Should the complication occur during the first or second week following the operation, its symptoms are very liable to be mistaken for those of peritonitis or septicæmia. If the condition is recognized, the abdominal wound should be reopened and the obstruction removed.

*Phlegmasia* may occur, especially during convalescence; and cases have proved fatal from portions of the clot becoming detached.

*Tetanus* also has been known to occur.

## Tumors of the Uterus.

Tumors of the uterus may be malignant or non-malignant. The former include sarcoma and carcinoma; the latter, fibromyoma, fibroma and fibrocysts.

### 1. *Non-malignant Tumors* ("*Fibroids*").

These resemble in their structure the tissues that normally form the wall of the uterus, but the proportions in which they occur differ very considerably. Some are soft, pale or flesh-colored, rapid in growth, and ill-defined in outline, consisting almost entirely of unstriped muscular fibre—"*mioma.*" Others grow very slowly, present a white and glistening surface on section, and are almost as hard as cartilage. These consist of nothing but fibrous tissue—"*fibroma*"—arranged concentrically layer upon layer. Unlike the former, they are almost non-vascular, and are surrounded by a capsule of loose connective tissue, which differentiates them from the surrounding uterine wall. In this loose fibrous tissue run the blood vessels which supply the tumor.

*Fibroids* occur with the greatest frequency during middle life, between the ages of thirty and forty-five. It is uncertain whether they ever originate after the climacteric; but they may continue to grow, and in some instances very rapidly, after that epoch. Sometimes they remain unchanged for years. During menstruation and in pregnancy they frequently increase very fast; subsequently they undergo involution with the rest of the uterus, and may disappear completely.

Fibroid growths are liable to degenerative changes of various kinds. Occasionally the central portions become changed into mucous tissue, and the soft semi-fluctuating tumor thus formed may readily be mistaken for a cystic tumor of the ovary. Sometimes cavities or cysts form in them, containing pus, blood or serum. Such cysts may attain an enormous size, and, like the preceding, simulate ovarian disease very closely. After the menopause, fibroids generally cease growing, but exceptions to this are not uncommon. They may atrophy and disappear; or they may undergo calcareous degeneration, the outer layers especially being affected so that sometimes they appear to be surrounded by a kind of shell. Sarcomatous and carcinomatous changes are supposed by some to occur in them, but it is open to question whether the occurrence of the two conditions in the same uterus is not a mere coincidence.

There is no limit to their number. They may occur in the cervix, but are much more common in the body of the uterus. Sometimes they grow in the centre of the uterine wall (*interstitial fibroids*); sometimes they develop on the surface, either the internal (*submucous*) or the external (*subperitoneal*). In this case they may either remain sessile or become pedunculated and project as polypi into the cavity of the uterus or that of the peritoneum. A submucous fibroid may be gradually separated from the uterus by an elongating pedicle and expelled by the uterine contractions into the vagina. Subperitoneal fibroids are also occasionally entirely detached from the uterine surface. When connected by a long pedicle these tumors are very liable to give rise to serious complications, from their tendency to fall into the pelvis and become incarcerated, or by becoming accidentally twisted on themselves and strangulated.

**Symptoms.**—These depend to a great extent upon the situation of the

growth. Sometimes they are entirely wanting, so that the tumors remain latent for the whole of life.

*Hemorrhage* is the most characteristic, and is rarely absent except in the case of the subperitoneal variety. With large interstitial growths it is often profuse. Usually it takes the form of menorrhagia coming from the hypertrophied mucous membrane of the uterus, and beginning as an aggravation and prolongation of the menstrual flow. With submucous fibroids it may occur at any time, coming from the ulcerated and granulating surface of the tumor, and accompanied by a profuse leucorrhœal discharge. This latter can be distinguished from the discharge present in cancer of the uterus, by being less watery and free from fetor.

*Pain.*—Discomfort, a sense of weight in the lower part of the pelvis, and bearing-down pains are generally present, and, owing to the increased size of the tumor, are always worse at the menstrual periods. The submucous and interstitial varieties are attended by characteristic uterine dysmenorrhœa, the tumors acting as a foreign body and exciting irregular contractions like the pains of labor. As a rule, this is not present in the subperitoneal form.

*Pressure.*—The urinary organs suffer the most frequently; an irritable con-

FIG 504.—Uterine Fibroids, Subperitoneal, Interstitial, and Submucous.

dition of the bladder may be excited by the presence of even a small fibroid. Suppression may occur from compression of the ureters; incontinence from the bladder being dragged into the abdomen and the urethra stretched; or retention if the tumor presses the urethra against the pubes. Sometimes this is intermittent, owing to the varying size of the growth during the menstrual period.

In other cases the rectum is compressed so that constipation and even obstruction are caused; and as the tumor grows in size, like large ovarian cysts, it very seriously interferes, by its mere bulk, with the working of the abdominal and even the thoracic viscera.

*Sterility and Abortion.*—Pregnancy seldom occurs when there is a submucous or interstitial fibroid of any size. If it does, either the patient miscarries, or, if the full term is reached, there is great danger of post-partum hemorrhage, and of metritis and pyæmia due to sloughing of the tumor.

**Physical Signs.**—These differ according to the locality.

1. *Submucous.*—If pedunculated and in the lower segment of the uterus, a fibroid can often be felt projecting through the cervix as a hard, smooth, rounded mass. It may be necessary to dilate the os before this can be done By introducing the finger into the cavity of the uterus, the position and extent of its at-

tachment can then be ascertained. If sessile, it may attain a large size, stretching the uterus like a capsule and reaching as high as the umbilicus.

2. *Interstitial.*—As with a former variety, the uterus is always increased in size. Its cavity, measured by the uterine sound, may be found to be six or eight inches in length. The canal is often rendered extremely tortuous by the tumors encroaching upon it, so that the passage of the sound may be very difficult or quite impossible. Small growths are difficult to detect. There is nothing but a peculiar lumpiness and sense of resistance in the walls of the uterus which the healthy organ does not present. A projecting growth may simulate a flexion of the uterus; but a careful bi-manual examination and the aid of the uterine sound will always obviate an error of this kind. When large, they rise up into the abdomen, occupying a central position, and form a solid, rounded, freely movable tumor, over which the uterine souffle can often be heard, especially at the sides. On vaginal examination the cervix is found displaced in various ways. It may be drawn up in the abdomen beyond the reach of the finger, or, if the lower part is involved, it may be altogether lost, the os appearing as a mere depression.

3. *Subperitoneal.*—In these the uterine cavity is not necessarily enlarged, and the uterine souffle is not present. In addition to the general mobility of the tumor, the growths have a certain range of free movement, depending on the length of the pedicle. Palpation gives the idea of a number of hard rounded masses rolling one over the other. This characteristic, when present, is absolutely distinctive.

**Differential Diagnosis.**—*From Pregnancy.*—When normal, pregnancy is easily distinguished; but a difficulty may arise if the fœtus is dead, and all the signs of pregnancy have disappeared, and there is a dark sanguineous discharge escaping from the enlarged uterus. This condition bears a close resemblance to the appearance presented by a partially detached submucous fibroid in process of expulsion. In extra-uterine gestation the history and rapidity of the growth are sufficient.

Pregnancy co-existing with fibroid sometimes presents a difficulty: in addition to the ordinary signs, most reliance must be placed upon the want of uniformity in the shape of the uterus, and the size, which is larger than would correspond to the period of pregnancy.

*From Ovarian Tumors.*—In these the uterine souffle is never heard; the cavity of the uterus is not enlarged, and the tumor, as a rule, is soft and fluctuating. Manipulation of the mass in the abdomen does not move the sound in the uterus unless the connection between the latter and the tumor is very close. Fibrocysts, however, sometimes cannot be distinguished.

Abscess of the ovary or Fallopian tube, hæmatocele and inflammatory deposits occasionally present a difficulty, especially as inflammation is not unlikely to occur around a fibroid if it causes pressure.

**Prognosis.**—This depends upon the age of the patient, the nature of the tumor, the rapidity of the growth, the amount of hemorrhage, and of pressure upon other organs. Sometimes fibroids cease growing or even disappear; and sometimes they are extruded and slough off, but these instances are exceptional. In many cases death results from hemorrhage, exhaustion, suppuration, peritonitis, sloughing of the tumor, intestinal obstruction or secondary renal mischief; in many more the patient's health is thoroughly broken down, and some intercurrent disorder sets in.

**Treatment.**—*Ergot.*—The hypodermic injection of ergot continued for many months is stated to have some influence in checking the growth of the tumor. Its action is very uncertain. The gluteal region is usually selected for the injection. The pain is extreme, and the punctures often suppurate. The practice has now been abandoned.

*Electricity.*—It is claimed that a constant current (commencing with 50 milliampères and increasing to 200 or 250) passed through the substance of the tumor at intervals of a few days will cause it to disappear, possibly by bringing into play

those conditions which sometimes normally during life bring about the same result. One electrode, insulated to within two or three inches of the point, is inserted into the cavity of the uterus; the other (usually the positive) is applied to the surface of the abdomen. The latter should be of very large size (seventy to eighty square inches), and very well and evenly covered with a folded linen cloth previously dampened in water, or with such currents the skin will be destroyed. Each sitting lasts five or ten minutes. Opinions are as yet divided as to the merits of this proceeding. In some cases there is no doubt the tumor has diminished or disappeared; in many it has been entirely unaffected; and in some, especially when high currents were used, sloughing and septicæmia followed. At present the method is entirely empirical.

*Enucleation per Vaginam.*—If the vagina is healthy and spacious, and the os and cervix capable of easy dilatation, small tumors, more or less pedunculated, may be removed this way; and sometimes it succeeds with large interstitial fibroids, but only—and this is almost impossible to tell—when they are encapsuled.

The patient is placed in the lithotomy position, the cervix having been previously dilated, if necessary. The uterus is pulled down as far as possible by means of a vulsellum, and the attachment of the tumor carefully made out with the finger. If there is a distinct pedicle an écraseur may be placed round it at once, or it may be twisted off.

If, on the other hand, it is sessile, a deep incision is made through the mucous membrane and the capsule at the most convenient spot, and the substance of the tumor seized with strong vulsellum-forceps. Then, while an assistant pushes the fundus down from the abdomen into the pelvis, an attempt is made to insert the finger between the capsule and the growth, and shell it out. Emmet's nail curette and Thomas's spoon-saw may be used with advantage, but all instruments add very greatly to the risk, especially as the fundus is approached, and great care must be taken in dragging upon the tumor not to invert the uterus, or its wall may be included in the écraseur and the peritoneal cavity laid open. The capsule is then washed out with iodine water and plugged with pledgets of cotton dipped in the same or some other antiseptic. These may be removed in forty-eight hours and the vagina washed out with a weak antiseptic night and morning until the discharge has ceased.

The operation is one of extreme difficulty. If any portion of the tumor is left it is certain to slough and very likely to cause septicæmia. The uterus does its best to extrude it, and sometimes a second operation may successfully complete the removal; but, except in those cases where the tumor is small or already presents at the os, the operation is not to be lightly undertaken.

*Removal of the Uterine Appendages.*—The object of this proceeding is to precipitate the menopause and so induce the condition of atrophy which may be expected to occur after that event. Sometimes it is performed with the view of checking hemorrhage, sometimes with the view of arresting the growth of the tumor. The operation is commonly known as Hegar's. It is most feasible when the tumor is interstitial and of moderate size, the hemorrhage periodic and excessive, and the normal menopause remote.

The patient is prepared as for ovariotomy. The abdominal incision is about three inches in length to begin with. The fore and middle fingers of one hand are slipped over the side of the uterus until the appendages are reached. The tube and ovary are drawn out of the wound, transfixed, ligatured and divided. The appendages on the opposite side are then treated in a similar way. The operation is never to be recommended when the tumor has attained a large size. The appendages are often displaced by the irregular outgrowths; they may be behind or buried in the pelvis beneath the tumor and quite inaccessible. In some cases they are flattened out and adherent to the growth, from which it is impossible to separate them. Great care must be taken not to wound the surface of the tumor during the operation; hemorrhage will ensue, which it is extremely difficult

to check. In such case the operator must be prepared to proceed with the supravaginal amputation of the uterus.

The mortality is small, and in many cases a successful result is obtained; menorrhagia is checked and the tumor ceases to grow; in some it has completely disappeared. Should it fail, the condition of the patient is not in any way deteriorated, and in suitable cases resort may be had to the graver operation of supravaginal amputation.

*Supravaginal Hysterectomy.*—This operation is advised when the tumor is large, especially if it is soft, growing rapidly, or attended with menorrhagia. It is necessary in cases of fibrocyst, unless the tumor is pedunculated. The age of the patient need scarcely be taken into consideration; the menopause is indefinitely deferred, and it is useless waiting for it when a patient's life is threatened by a bleeding myoma. Its applicability is, however, limited to those cases in which sufficient of the cervix remains in a healthy condition to be utilized as a stump.

The instruments required are the same as those for ovariotomy, with the addition of Kœberlé's serre-nœud, a pair of pliers, two long pedicle-needles, and a Tait's screw. The latter resembles a large corkscrew, and is often of great service in the extraction of the tumor. A second serre-nœud should be in readiness.

The patient is prepared as for ovariotomy. An incision about four inches in length is made in the median line, care being taken not to injure the bladder, an accident which is far more likely to happen than in ovariotomy. The abdominal walls are usually very vascular, and all bleeding points must be secured with pressure forceps. On exposing the tumors, the dark fleshy appearance of a uterine fibroid will at once be recognized.

The relations of the tumor to the broad ligaments are then explored, and if it appears capable of removal, the incision is enlarged to the necessary extent. A fibroid cannot be pulled out of the abdomen unless the incision be carried almost to the level of its upper border, especially if the tumor is broad. The incision may be carried through the umbilicus or to the left of that structure as far as required.

The presence of adhesions is then ascertained. These are most frequently omental, the vessels being sometimes enormously dilated. They must be secured by ligature, both on the proximal and distal side, and divided.

The tumor is now raised through the abdominal opening—not always an easy matter. It is slippery, possibly wedged in the pelvis, and a hand passed behind it fills up the abdominal opening to such an extent that it is impossible to lift it out without unduly enlarging the incision. The screw may then be thrust into the most prominent part, with its point directed toward the fundus. By depressing the handle and raising the point, at the same time drawing the tumor forward, while with the other hand the abdominal wall is retracted over the fundus, it may be successfuly coaxed out of its bed. The abdominal viscera are at once protected by a large, warm, flat sponge, which is pushed under the parietes. Any further adhesions are attended to, and the relation of the bladder to the front of the tumor ascertained, a sound being passed into the bladder, if necessary, for that purpose. It may be necessary to dissect it from the tumor.

The wire of a Kœberlé's serre-nœud is then passed around the tumor at the level of the os internum, including the tubes and ovaries and the greater part of the broad ligaments, which are pulled up by the assistant above the level of the wire. The loop is then tightened by means of the key, taking care that the bladder is not included.

No difficulty is experienced when the appendages lie evenly and high up on the sides of the tumor. If they are situated too low to be included with safety in the loop, they must be removed separately.

When the tension on the broad ligament is excessive, it may be transfixed with a stout ligature close to the neck of the uterus and tied between the uterus and the ovary. The larger vessels being controlled by this, the peritoneal envelope of the uterus is freely divided at a distance of about three inches from the wire loop

be made out in the early stages, and later an irregular ulcerated surface. Rectal examination should never be omitted.

In carcinoma of the body of the uterus pain is an early and marked symptom; the cervix is normal or dilated; the uterus enlarged; hemorrhage always follows the introduction of the sound. Introduction of the finger through the dilated cervix as a rule confirms the diagnosis at once.

**Treatment.**—When the disease is confined to the vaginal portion, the cervix may be removed. When the canal is involved the extent of the disease must determine the necessity for partial or complete hysterectomy. Cancer involving the body can be treated only by complete extirpation.

*Amputation of the Cervix.*—This may be performed in various ways: with the galvano-cautery, the écraseur, or the knife and scissors.

The patient is placed either in the semiprone or lithotomy position. The cervix is exposed by means of a Sims' speculum, and drawn down with a vulsellum to the vulva. The wire is passed over the handle and adjusted around the cervix as high above the disease as possible. Care must be taken not to place the wire too high posteriorly for fear of cutting into Douglas's pouch. The circuit is closed, the wire kept at a dull red heat, and just sufficient traction maintained to keep the wire against the part to be severed. The operation requires several minutes. Hemorrhage is usually avoided, but it may occur, and the possibility of secondary bleeding is not to be lost sight of.

The écraseur is more portable but less safe; the chain is not so easily manipulated and there is greater danger of cutting into Douglas's pouch. For this reason a curved écraseur is best.

*Supravaginal Amputation of the Cervix.*—The cervix is drawn down and a semicircular incision made in the anterior reflection of the vaginal mucous membrane with a scalpel or blunt-pointed scissors. The bladder is easily separated by the finger, and retracts upward, carrying the ureters with it. The utero-vesical pouch of the peritoneum must not be opened. The cervix is then pulled forward to the pubes, and a semicircular incision made through the posterior reflection of the vaginal mucous membrane, its extremities uniting with those of the anterior, so that the cervix is entirely free from the vagina. Douglas's pouch is liable to be opened, but this is of little consequence; if the posterior lip must be divided high up, it is better to cut into the pouch and remove the peritoneal covering with the portion amputated. The clearing of the cervix laterally is more difficult, on account of the firmness of the connective tissue and the presence of large branches of the uterine artery. Bleeding vessels should be secured at once with pressure forceps and then tied. As soon as the cervix is freed all round, the knife is carried through the anterior wall at the required height, obliquely upward toward the canal, and a conical portion excised from the interior. The anterior and posterior vaginal walls are stitched to the lips of the cervix, and sutures are also inserted laterally; they help to control the hemorrhage. The ureters retract so that they are not in danger of being caught. By this operation a considerable portion of the body of the uterus may be removed as well as the cervix. It is not free from danger; even with the best statistics there is a mortality of twelve per cent.

*Extirpation of the Uterus.*—This may be done either by abdominal section through the vagina [or through the sacrum]; the mortality in the case of the former [formerly high, has now been brought so low by improved technique as to cause it to be preferred. The whole uterus is rarely removed in comparison with partial removal. The cervix is usually retained, as in the following operation: The operation consists in the removal of all that portion of the uterus above the vagina, and is thus performed: The abdomen is opened rapidly through the median line and the uterus disengaged by the hand or fingers from its superficial adhesions, a sound is passed into the bladder to establish the exact relation, and when entirely free an elastic cord ligature is placed tightly around the cervix;

some surgeons with two heavy pins transfix the uterus just above the point of application of the ligature, to keep it from slipping and, as well, from including a portion of the bladder. The uterine adnexa are then tied and removed, an antero-posterior incision made, and the uterus with the tumor removed. The uterine stump is now cauterized with the Pacquelin cautery to prevent infection of the wound. If intended to treat it extra-peritoneal, the stump is now drawn out of the wound, leaving the pins and the ends of the elastic ligature projecting. If an intra-peritoneal method is desired, the stump, after cauterization with acid or actual cautery, must be carefully sutured and the peritoneal coat of the uterus brought in accurate apposition. By the extra-peritoneal method (Hegar), the stump being brought out of the wound, and the abdominal wound made to enclose it firmly, the cut surface is thus extra-peritoneal, and the possibility of infection reduced to a minimum. The wound is dressed by placing a tamponade of cotton over it, wet with solution bichloride of mercury or chloride of zinc, and over that iodoform gauze.]

The first steps in vaginal hysterectomy are identical with those already described for supravaginal amputation of the cervix; the later ones admit of innumerable modifications. A circular incision is made in the vaginal vault, the bladder separated from the cervix as far as the utero-vesical fold of peritoneum, and a free opening made into Douglas's pouch. Two fingers of the left hand are passed in over the fundus uteri into the vesico-uterine pouch, and the peritoneum is divided anteriorly by cutting down upon them through the wound in front of the cervix. The uterus is now free in front and behind.

The uterus must now be forcibly pulled down. If it can be brought outside and fully exposed, the broad ligaments may be secured by ligatures, and the uterus cut away. If this cannot be done the ligament must be clamped on one side as close to the uterus as possible, and then the tissues divided on the uterine side. There is no difficulty then in transfixing the other ligament, ligaturing it in two halves, and cutting it away. The clamp may either be left on for forty-eight hours or ligatures may be applied to this as well. If the ovaries and Fallopian tubes are allowed to remain, the stumps are sufficiently long to ligature easily; but if they are removed the ligatures are liable to slip.

Another method is to secure the broad ligaments in segments, first on one side and then on the other, drawing down the uterus bit by bit, in a zigzag manner.

Great care must be taken to avoid injury to the ureters or including them in the ligatures. These must be placed as near the cervix as possible; the ureters are less than half an inch to the side—higher up they are a little further off.

No sutures are required; the parts fall naturally into apposition. If the clamps are used and left they serve as a drain; if not, a glass tube must be passed into the peritoneal cavity and left for three or four days. If the discharge becomes offensive the wound must be thoroughly irrigated with an antiseptic by means of a catheter. The tube should be surrounded with antiseptic wool where it lies between the labia, but any further plugging is unnecessary. Hemorrhage is the chief risk, either during or after the operation.

Caution must be exercised in separating the bladder, as its walls are very thin.

**Mortality.**—In amputation of the cervix with the cautery this is only 7 per cent.; in the supravaginal operation, the best results give 12 per cent.; but in complete extirpation it is as high as 28.6 per cent. This, however, cannot be regarded as final. Later results are much better, as might have been expected.

The **prognosis**, so far as cure is concerned, is very unsatisfactory. Recurrence either in the scar or in the perinterine tissue invariably occurs within a few months.

Cancer of the body is so rare and so seldom diagnosed in time that complete extirpation can hardly ever be performed.

### Operations about the Vulva and Vagina.

*Vascular tumors* frequently occur at the orifice of the female urethra. They form small, florid excrescences, sometimes attaining the size of a large pea, and give rise to increased frequency and pain on micturition, with hemorrhage not unfrequently. Sometimes the symptoms bear some resemblance to those of calculus in the bladder. The mucous membrane around and extending up the urethra is often involved in the vascular growth. The tumor should be removed with a pair of fine-pointed scissors. If the mucous membrane is involved, it must be thoroughly treated with the cautery. The condition is very liable to recur.

*Cysts of the labium* are generally due to obstruction of the duct of Bartholin's gland. The cyst usually contains a glairy, colorless fluid and is very liable to suppurate. Simple incision is not sufficient; the cyst invariably refills; if possible, it should be enucleated, and if this cannot be done a portion of the wall should be excised and the interior thoroughly cauterized with nitrate of silver.

*Fibrous and fatty* tumors are occasionally met with in the labium, and need no special comment.

*Cysts of the vagina* are not of very infrequent occurrence. They result from distention of mucous follicles, and sometimes attain the size of a small egg. When small they cause no trouble; when large they produce the symptoms of a foreign body, and may excite a chronic leucorrhœa. A portion of the cyst-wall should be excised and the interior of the sac freely cauterized. Enucleation should not be attempted.

*Vesico-vaginal fistulæ* result usually from sloughing following protracted and difficult labor, or ulceration around a foreign body impacted in the vagina. They give rise to great distress, owing to the constant escape of the urine and the irritation of the skin which it causes. The fistulæ vary much in size—some hardly admit a probe. In severe cases nearly the whole of the anterior wall of the vagina may be destroyed. When small, the opening may be detected by filling the bladder with milk; the point where it flows into the vagina will then be readily seen through a speculum. Vesico-vaginal fistula is most usually found about half an inch in front of the cervix uteri, sometimes close to it. Very occasionally it opens into the uterus itself—utero-vesical. When the fistula is very small, touching it with the actual cautery may succeed in closing it, but the proceeding usually terminates in failure, and an operation has to be undertaken. The patient may be placed either in the lithotomy or semiprone position, a duck-bill speculum introduced, and the uterus drawn down as low as possible with a tenaculum. The edges of the fistula should then be pared and brought together with sutures placed sufficiently close to prevent the passage of urine between them. The operation is often very tedious and difficult, on account of the difficulty in getting at the parts. Various ingenious needles and needle-holders have been invented with a view to overcome this. The bladder should be emptied by a catheter every eight hours for the first three days, and the stitches removed at the end of a week.

*Recto-vaginal fistulæ* may occur from the same causes as the preceding. They are commonly situated just within the entrance of the vagina, and may be treated in a similar way.

*Laceration of the cervix uteri* is also a result of labor. It is frequently attended with great hyperplasia and cystic degeneration; the lips tend to become everted (*ectropion*) and expose the inner surface of the cervical canal; this exposed surface very soon becomes denuded of epithelium, and is the source of a profuse catarrhal leucorrhœa; the condition persists indefinitely and may be the cause of many troubles, both local and general. "Trachelorrhaphy" is the term applied to the operation proposed by Emmet for the repair of the laceration.

The patient is placed in the lithotomy position, and the uterus drawn down as far as possible by means of a tenaculum. The lacerated surfaces are well exposed, and a strip of mucous membrane removed on either side, leaving a broad tract undenuded between them; this tract will form the cervical canal and external os

when the operation is completed ; the flaps are then approximated and the sutures applied. The insertion of the sutures is not an easy matter, owing to the difficulty of getting at the parts and the toughness of the uterine tissue. A short, very stout, and slightly-curved needle is required and a strong needle holder ; the needle should be armed with a silk loop, and when it has been inserted through both lips, a silver wire threaded into the loop should be drawn into position ; three or four sutures will be required on either side ; they are best secured with a coil and clamped shot, and one end left long to facilitate removal. They may be removed on the seventh day, though some prefer to leave them until the tenth or even longer, as they seem to cause but little irritation. The operation should not be undertaken if there is any pelvic inflammation or cellulitis.

*Rupture of the perineum* is also an accident of labor. It may be "partial" only, extending through the fourchette, or "complete," involving the sphincter ani and more or less of the recto-vaginal septum. An attempt should always be made to repair the injury at the time of the accident, although it is not always successful. Innumerable modifications have been proposed, and are employed by different operators in the repair of the perineum. The operation for complete rupture is as follows: The bowels having been well opened and an enema administered the same morning, the patient is placed in the lithotomy position. An assistant stands on either side supporting the patient's knee under his arm ; with one hand he draws the labia apart, and the other is free to assist the operator. Sitting in front of the patient, the operator inserts the first and second fingers of his left hand into the anus, and putting the parts upon the stretch, he denudes the surface in the following manner: At a point about half an inch external to the septum, the point of a scalpel or pair of scissors is passed into the tissues and carried along between the mucous surfaces of the vagina and rectum, dividing the septum into an anterior and posterior flap ; the incision is terminated at an equidistant point upon the opposite side. Sometimes the line of incision is more or less marked out by an area of pale cicatricial tissue, but this is not always so. From either extremity of this transverse incision, another is carried forward to the lesser labium, and backward to the extremity of the anal orifice. In this manner an H-shaped incision is formed. The incisions must be freely made, or the surface denuded will be insufficient to form a strong perineum, and the flaps will require further dissecting up. Hemorrhage is generally considerable, but can be kept in check by sponges and pressure forceps ; ligatures are not required. The free edge of the anterior flap is secured by a couple of forceps and held up by the assistants on either side ; the sutures are then inserted. Some prefer to bring together the mucous membrane of the anus first, but no advantage is gained by this. Either silver wire or silk-worm gut may be employed. Commencing at the lower part, the needle, which is moderately curved and mounted on a strong handle, is entered on one side about a quarter of an inch from the margin, or, as represented in the figure, into the denuded surface just within the margin. It is then carried between the layers of the recto-vaginal septum and brought out in the middle of the denuded surface, threaded with one end of the suture, and withdrawn. The needle is then passed on the opposite side in a similar manner, the point being made to emerge at the same hole. It is threaded with the other end of the wire, withdrawn, and the suture thus completed. Three or

FIG. 505.—Incision in Rupture of the Perineum.

four sutures are passed in this way through the recto-vaginal septum; one or two more are required in front, and one or two for the rectum. In passing the rectal and vaginal stitches, care must be taken to enter them just at the cut edge of the mucous membrane, so that perfect adaptation of the raw surfaces may be ensured.

The sutures having been all inserted, the wound is carefully sponged, and the patient's knees brought together. The sutures are then tied firmly, but not too tightly, commencing from the lowest; the wire may either be twisted or secured with shot and coil. The wound is dressed with some absorbent wool and a T-bandage applied. A morphia suppository should be administered, as the pain after the operation is often very considerable.

The repair of a partial rupture is generally unattended with much difficulty.

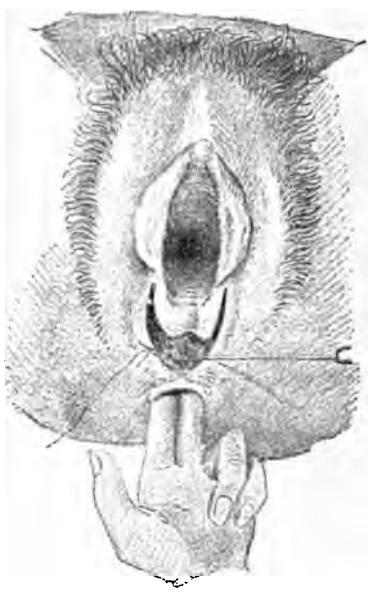


FIG. 506.—Method of Inserting Sutures.

FIG. 507.—Sutures in a case of Ruptured Perineum.

A V-shaped incision is made through the integuments, the apex being just in front of the untorn remains of the perineum and the branches extending to the labium minus on either side. The anterior extremities of these are united by an incision which crosses the mucous membrane about an inch and a half from the apex, and the enclosed surface is then denuded; or the V-shaped flap may be dissected up and carried forward. Sutures are inserted as in the previous operation.

The **after-treatment** consists in keeping the parts clean. The catheter is required every eight hours for some days. The bowels generally have a tendency to act of themselves about the fourth or fifth day. This may be encouraged by a mild aperient followed by an enema. It adds greatly to the discomfort of the patient to keep them confined by means of opium, and is quite unnecessary. The stitches may be removed about the eighth or tenth day.

# CHAPTER XXVI.

## *DISEASES OF THE BREAST.*

### Abnormal Development.

*Complete absence* of the mammary gland is very rare; imperfect evolution at puberty, the breast retaining the infantile type, is not unfrequent, especially when the sexual organs are not developed.

*Polymastia* is more common. In most instances, the supernumerary structures are quite rudimentary, merely imperforate nipples with a linear depression and no areola; but sometimes they are well-formed glands, functionally active. Usually they lie in pairs along the line of the internal mammary artery, and are lower down upon the thorax; but a few instances are recorded in which they have been found above the normal level, in the median line, and even in distant parts of the body and upon the limbs. In addition to this, milk-producing tracts of integument, and, more rarely, small, well-defined glands, are, as Champneys has pointed out, occasionally developed in the axillary region during the lying-in period.

*Hypertrophy.*—Proportionate overgrowth of all the parts of the breast is very rare, but cases of enormous and rapid enlargement, affecting the connective tissue only, are not uncommon in young women about the time of puberty, and even in men. It may affect one side or both, and the size may be so great that the patient is scarcely able to support the weight. The skin is thickened and rather coarser in texture, and the areola much longer than natural; but in other respects there is no very conspicuous alteration, and the consistence is perfectly uniform, which serves to distinguish this at once from enlargement due to rapidly growing tumors. Nothing is known as regards cause, and no treatment has any effect. Excision may be performed if the inconvenience becomes extreme, but the operation is not a light one. In a few cases the enlargement increases very seriously during pregnancy; in the majority the breast either fails to secrete altogether, or does so only to a very limited extent.

### Affections of the Nipple and Areola.

Inflammation of the nipple is of common occurrence during lactation, owing to the constant moisture and friction to which the part is subjected. The delicate epidermis is detached, leaving a superficial excoriation; this deepens into a fissure, usually between the rugæ or at the base, and in bad cases ends in serious ulceration. The pain when the part is touched, or an attempt is made at suckling, is simply agonizing, and even when mammary abscess does not follow, often leads to grave impairment of health and strength.

It usually occurs with the first child, and in those whose nipples are ill-developed. During the period of pregnancy the skin should be carefully hardened by bathing it night and morning with spirits and water, and, if there is any need for it, the nipple should be gently drawn out by suction through a properly contrived tube. Afterward the greatest care must be taken to keep it as dry as possible, and to cleanse it thoroughly every time the child leaves it. If there is the least excoriation, a mild or soothing ointment, such as almond oil, may be applied, and a shield should be used. If it continues and forms a fissure, it may be necessary to make use of a breast-pump, in order to save the patient the pain. Lead lotion, glycerine and tannic acid, styptic colloid, and similar remedies may be used at first (taking care that the nipple is cleansed before the child is put to it); but if the ulceration persists, it is better to touch the base with

nitrate of silver, the pain being prevented by applying a solution of cocaine first. When the scab drops off, the epidermis is sound beneath, though very thin.

In addition to this, *eczema* of the nipple is occasionally met with during suckling, the locality being determined in all probability by the continual moisture; *abscesses* may occur in connection with the sebaceous glands of the areola; small *sebaceous cysts* and *papillomata* may develop, and, especially in wet-nurses, typical syphilitic *chancres* may form, the infection being derived from the fissures and mucous patches so commonly found at the angles of the mouths of infants suffering from hereditary disease.

### Paget's Disease.

Eczema of the nipple must be distinguished from a peculiar disease of the skin closely resembling it, which was first described by Paget, and which is of great importance from the frequency with which it ends in carcinoma. It affects the nipple and the areola. The surface in most cases is raw, intensely red, and finely granular, like that of an acute diffuse eczema, with a copious yellow and viscid discharge. In others it resembles a more chronic form, or it is like psoriasis, spreading beyond the areola, and covering the breast with scattered blotches. Nearly always there is itching and sometimes a sensation of burning. The base is always considerably thickened, and occasionally the ulceration is so extensive as to lead to destruction of the nipple.

The chief features distinguishing it from ordinary eczema are the well-defined margin it presents, and the evidence of deeper infiltration of the papillary layer of the corium. What proportion of cases ends in carcinoma (it is probably a large one), and how long it continues before this breaks out, are questions still unsettled, but the intimate connection of the two (though not their identity), may be considered as well established. The usual form is duct or villous carcinoma, but the squamous type may occur.

The microscopic appearances, according to the earlier observers, merely presented a certain degree of proliferation of the deeper layer of the epithelium. with small-celled infiltration of the corium beneath, dilatation of the ducts, proliferation of the secreting cells in the acini, and finally the invasion of the epithelium and the development of carcinoma. Recently, however, another signification has been assigned by Darier, Wickham, and others, to certain peculiar highly refractile cells that are present in the epidermis and in the ducts of the milk and sweat glands, and are usually best developed at the growing margin.

They may be found, in a scraping of the surface mixed with water, though their relation to the other cells can only be seen in sections. When small, they are difficult to distinguish; as they increase in size a doubly refracting membrane forms around them; the other cells are pushed aside or altered in shape, and at length they develop into peculiar rounded bodies, much larger than the other cells, and either containing a mass of protoplasm, or else divided in two, very much in the fashion of a spore-bearing cyst. The irritation causes the superficial layers to desquamate, the inter-papillary processes grow larger, and at length the exudation accumulates to such an extent that the line of separation between the epithelium and the corium disappears.

These cells are said to be psorosperms or coccidia, and to belong to the sporozoa. Undoubtedly they are characteristic of the eczematous stage, and, according to Wickham, they occur not only in the consecutive carcinoma, but in other forms of cancer as well. Similar structures have been described in connection with molluscum contagiosum. Cultivation has not succeeded, but it is significant that after maceration in water for sixteen days, when all else had disappeared, they still remained intact.

Free removal is the only treatment. In many cases this means excision of the breast, as the nipple with the areola and the skin around must be taken away.

It is possible, however, if the view that the disease is really the product of these psorosperms receives confirmation, that microscopic examination of obstinate cases of eczema may lead to earlier operation, while the disease is still limited, and before such drastic measures are necessary.

## INFLAMMATION OF THE BREAST.

Inflammation of the mammary gland may be acute or chronic. The latter (with chronic abscess) will be dealt with by itself, as its pathology is not certain

### Acute Inflammation.

This is common at birth, puberty, and during lactation. At other times of life it may be caused by violence, but it is, comparatively speaking, rare, and syphilis, tubercle, and other specific diseases seldom attack the gland (chancre, of course, is different). The starting point is usually some slight injury, such as friction or a blow. When it occurs at birth or puberty, it nearly always undergoes resolution, although suppuration may occur as in other parts. On the other hand, when it breaks out during lactation, suppuration is exceedingly common, the pyogenic organisms entering either through cracks and fissures of the nipple, or, possibly, finding their way up the ducts into the acini and the perlacteous spaces.

1. *At Birth.*—The breasts of infants of both sexes often secrete a milk like fluid for a few days after birth. The gland is slightly swollen on the third or fourth day; this reaches its maximum by the end of the week, and then subsides. The only treatment necessary is to protect the part from injury. If the skin is very hot, or the swelling continues to increase, a compress wetted with warm lead lotion may be laid upon it, but no attempt should be made to rub the milk away. If suppuration occurs, it must be treated as an ordinary abscess.

2. *At Puberty.*—The same thing is occasionally met with at this time, owing to the rapid developmental changes that take place, but unless there is some injury, or the general health is greatly enfeebled, suppuration rarely occurs.

3. *During Lactation.*—Toward the end of pregnancy, and during the first few weeks of lactation, inflammation of the mammary gland is exceedingly common, as might be expected from the extreme rapidity and extensive character of the changes through which it passes. It may be caused by any trivial injury, even the persistent drawing of an infant at a breast that cannot secrete, or the accumulation of the milk in one of the lobes. The whole gland, or the affected part, becomes even more tender than the free and very painful. [illegible] it feels firm and dense, and if the area [illegible] large or near the surface, the skin is redder and warmer than that of the opposite side. In addition, there is usually a certain degree of [illegible] in most cases to say how far it is due to the effects of the gland. Rigors or chills rarely occur without suppuration. The sense of illness may [illegible] the end of pregnancy [illegible] having borne many children [illegible] when the gland [illegible]

The treatment depends upon the [illegible] inflammation [illegible] arm to the side [illegible] position [illegible] it is to be [illegible] beneficial, and may [illegible] are inclined to [illegible] this is not sufficient. The nipple must be carefully examined to see if there are any fissured cracks. Fissured nipples must be gently rubbed over with Vas-

tion toward the nipple. The milk must be drawn off with a breast-pump, or better with a suction tube. The patient must be confined to bed, the breast well supported from beneath and at the side, and gentle pressure applied around the gland, except toward the axillary border. If this does not succeed, lead lotion, or lead with opium or belladonna, may be applied; but, as a rule, if the attack is taken in time, these may be dispensed with. Constitutional measures must be guided by the condition of the patient. If the gland is at rest, or if the inflammation commences in the earlier weeks of lactation, and the attack is acute, and the bowels confined, saline purgatives are very beneficial. If, on the other hand, the patient is weak and exhausted, and has been already suckling too long, the bowels may require to be opened, but quinine and other tonics should be given instead.

### *Mammary Abscess.*

Suppuration occurring in the mammary gland at birth or puberty requires no special description; it follows inflammation as a natural consequence if the vitality of the tissues is much lowered, and if the pyogenic organisms are brought in sufficient numbers by the blood. That variety, however, which breaks out toward the end of pregnancy or during lactation, when the gland is in a state of full physiological activity, is very different.

It usually occurs either with the first child, in the first few weeks after parturition (and then it is nearly alway associated with cracked or defective nipples), or, in those who have borne many children, as a result of unduly prolonged lactation. One or more of the lobules become inflamed; the pyogenic organisms gain entrance, sometimes through the blood-stream, much more frequently through some minute excoriation of the nipple (the lymphatics of the breast radiate from this point through the gland to its base, and then for the most part run on the surface of the pectoral fascia to the axilla), or, perhaps, through the ducts themselves; and suppuration follows, diffuse or limited, according to the size of the area inflamed and the vitality of the tissues involved.

It is usual to divide mammary abscesses into three classes, according to their situation—superficial, intraglandular, and submammary.

(*a*) *Superficial Abscesses.*—These require no special description; they should be opened and drained as soon as the diagnosis is made, to prevent the skin becoming undermined.

(*b*) *Intraglandular* ones are more serious. It is probable that they may begin either in the lobes themselves, or in the loose cellular tissue around them; but it is rarely possible to distinguish one from the other. The earlier symptoms, those due to the inflammation, have been described already; suppuration may begin acutely, with a definite chill; more frequently the pain and swelling merely grow worse and worse; the breast becomes larger and larger (the nipple often being retracted owing to the tension on the ducts) without its being possible to indicate any definite locality as the seat of the mischief, and the constitutional symptoms more and more severe. After a few days, when the tough fibrous tissue that surrounds the suppurating lobule (if it commences in one) has given way, there is often a certain degree of improvement; the pain is less severe, and the temperature falls a little; then, by degrees, the skin at one spot becomes thickened, œdematous, and tied down, giving some indication as to the direction in which the suppuration is progressing, and at length one spot softer than the rest can be made out in the centre of the swelling.

The sooner the pus is evacuated the better, but it is necessary to wait until some idea can be gained as to its position and the direction it is following; exploratory operations in a breast in a state of full physiological activity are not advisable. The incision should be free, radiating from the nipple so as not to cut the ducts across, and suitably arranged for drainage. As the interior of the abscess is always irregular in shape, it should be thoroughly explored with the finger; a drainage-tube introduced into every pocket; and the whole circumference packed

with soft absorbent dressings, so that the fluid that exudes may be driven toward the opening. More than one incision may be required if the abscess is allowed to burrow in all directions through the gland before it is opened. Such cases, and still more those in which the pus is left to work its way out as it pleases, often leave irregular sinuses which persist for years, draining the patient's strength, and ultimately leading to the destruction of the gland as a secreting organ.

(*c*) *Submammary* abscesses are fortunately rare. They may commence in the deeper lobes of the gland and spread through the subjacent fascia, or be due to direct infection through the lymphatics. In many cases they are associated with symptoms of pyæmia, and probably they are often embolic. The breast itself is but little affected; it is thrust out from the chest-wall and floats as on a water-bed. Sometimes they develop insidiously; more often they are attended with very severe symptoms. If left, the skin usually gives way below the gland; but frequently large tracts slough, leaving great cavities fringed with blue, congested, overhanging flaps. I have known an abscess of this kind extend from the sternum to the spine, undermining the skin and destroying the cellular tissue half-way round the body before it broke. Great care must be taken in opening these to secure efficient drainage, and to bring the opposing surfaces into accurate contact, so that no decomposing pus may be retained in outlying pockets.

### Chronic Inflammation.

Chronic interstitial mastitis, affecting one or more of the lobules, is of very great importance, from the pain and anxiety it occasions and from the difficulty of distinguishing it from the early stage of scirrhus. The interacinous spaces are filled with a small-celled infiltration, which becomes organized and contracts into dense cicatricial tissue. The acini disappear or become converted into retention cysts, filled with a clear but often colored liquid; and by degrees the lobule becomes changed into a hardened mass of very irregular shape, adherent to the structures around (so that it cannot be pushed about like a fibro-adenoma); and sometimes, if it involves one of the larger ducts, attended with retraction of the nipple.

No cause can be found in the majority of cases. It is most common about the menopause; it is often associated with disorders of menstruation, and at each period it usually becomes painful and tender; but, on the other hand, it may occur at any age and in those who are to all appearance perfectly healthy. Pain, often of a neuralgic character and sometimes very severe, and made much worse by handling, is usually the first thing noticed; and the induration is only found on examination.

The **diagnosis**, so long as the patient is under thirty years of age, is not very difficult (although the possibility of carcinoma must not be overlooked); in older ones it rests chiefly upon the physical signs. The hardness is not of that stony description characteristic of contracting scirrhus; the surface is usually more nodular, from the presence of cysts); it may vary in size at each menstrual period; sometimes there are several separate lobules in the same condition, either in the same or in the other breast; and it may have been present too long. In many cases, however, the difficulty is so great and the risk so disproportionate that every endeavor should be made to induce the patient to submit to an exploratory incision; the question can be settled by the microscope while the patient is still under the anæsthetic.

The **treatment** of chronic interstitial mastitis is very unsatisfactory. Sometimes it slowly undergoes resolution or disappears so far that the patient takes no more notice of it, but it is rarely possible to connect this with any particular remedy. Paget recommends small doses of iodide of potash with liquor potassæ, well diluted; and of course any menstrual irregularity must receive careful attention. Tonics (especially iron) often succeed better than anything else; but the chief thing is to protect the breast against every source of irritation, and to

withdraw it as far as possible from notice, by covering it with a well-shaped belladonna plaster.

### *Chronic Abscess.*

Thick-walled chronic abscesses are occasionally met with in the breast without any definite sign of inflammation around them. They may commence during lactation or after miscarriage, but they are also met with independently of any such cause, after injury. In some instances they may be of tubercular origin, the caseous material gradually becoming surrounded and encapsuled. Their importance is derived from the extreme difficulty of distinguishing between them and carcinoma. Like it, they are a distinct addition to the substance of the gland (in which they differ from chronic interstitial mastitis); they are intensely hard, painful when handled, and adherent to the structures around; and sometimes they drag distinctly upon the skin and the nipple. It is true that a certain amount of œdema may be present over the swelling, but this by itself is too slight a sign on which to base so important a diagnosis; and they have been known to last for months and even years, without any other change than a slight increase in size.

The only treatment is free incision and drainage, scraping the interior out thoroughly if the wall is dense and hard. If the diagnosis is in the least uncertain, a preliminary incision should always be made before attempting anything further; for want of it the gland has before now been removed, under the impression that the case was one of scirrhus.

*Gummata* are met with in the breast, but very seldom. Masses of caseous material, possibly of tuberculous origin, are rather more common, forming a considerable proportion of the so-called galactoceles. If allowed to break, they leave chronic ulcers and sinuses fringed with congested flaps of skin, similar to those met with in other parts of the body.

## TUMORS OF THE BREAST.

These are simple or malignant. The former include the various kinds of cyst and the different forms of mammary glandular tumor; the latter, carcinoma and sarcoma. In addition, melanotic sarcoma and papilloma may grow from the nipple and areola; squamous carcinoma may extend inward from the skin as a result of Paget's disease (usually this gives rise to duct cancer); and nævi, lipoma, chondroma, and some other forms may occur; but they do not so much belong to the breast as to the structures around.

In the case of a suspected tumor, the first proceeding is to exclude lobular induration. The patient should be placed in a semi-recumbent position; the dress arranged so that the whole of the gland is uncovered; and the arm freed from all restraint. Then, before the fingers are allowed to feel it, the palm of the hand should be laid flat upon the suspected spot, and made to roll the lobules gently over each other. If there is a new growth it stands out distinctly as an addition to the gland; if, on the other hand, there is merely lobular induration, it can scarcely be felt unless the breast is very thin. If this precaution is neglected, and the hardened tissue is grasped with the fingers first, whatever its nature, it feels exactly like a tumor. Even this, however, fails to distinguish simple induration from malignant infiltration (scirrhus) in its early stages.

No examination is complete without thorough investigation of the axilla. The arm should be only moderately abducted, and the glands along the margin of the pectoral muscle felt for first, then those that lie along the axillary vein and at the apex. Unfortunately, even with the greatest care, it is only possible to detect them when they have attained a considerable size.

### Cysts.

Cysts of the breast may be simple or filled to a greater or less extent with new growths of various kinds—papillomatous, adenomatous, sarcomatous, or

carcinomatous. As the importance of the latter class is derived from the solid structures associated with them, they will be dealt with later, under their several headings.

*Dermoid and hydatid cysts* have been known to occur, but they are very rare; by far the majority of cysts are developed in connection either with the fibrous stroma or the gland tissue.

*Cysts developed from the fibrous stroma* (*serous cysts*) are usually single and more or less globular in shape, but they may be multiple and very irregular. Their walls are formed of fibrous tissue lined with epithelioid cells, and they contain a clear, albuminous liquid. The mode of origin is very doubtful, but possibly, like the similar cysts occasionally met with in the neck, they are connected with the lymphatic interstices.

*Glandular Cysts.*—Of these there is a great variety.

(*a*) *Involution Cysts.*—After the period of activity is past, the mammary gland not unfrequently becomes studded with numbers of small cysts, developed not so much from the acini (which atrophy and disappear) as from the minute ducts. If there is a coincident development of fat, this change is not noticed; but in thin people, and especially when the change is prominently developed in one particular lobule, it may give rise to great uneasiness, owing to the peculiar hardness of the cysts. Their rounded shape, however, the free mobility, the absence of any adhesions, and the presence in nearly every case of a similar transformation, either in other parts of the same breast or in the opposite one, are usually sufficient to make the diagnosis certain.

(*b*) *Cystic Degeneration.*—This is more rare. The whole gland, or the greater part of one, becomes studded with myriads of minute cysts, developed from the acini. They are lined when small with low columnar epithelium; as they increase in diameter the cells become flatter, until in the largest (which may be the size of a small marble) they are almost pavement-like; and they contain a clear, albuminous fluid, which may be green or brown, and even almost black in color, from the admixture of hæmoglobin. In some cases the basement membrane of the acini is greatly thickened as well. This has nothing to do with the period of involution: it occurs at a much younger age, and only affects one, and sometimes only part of one of the glands, but its real nature is very obscure. Clinically, it causes a rapid, uneven enlargement, with the development of very irregular, hardened nodules; and if the cysts are near the surface, and sufficiently large to admit of recognition, it is usually taken for a variety of cystic sarcoma.

(*c*) *Cysts Due to Chronic Inflammation.*—Minute cysts are often present in chronic interstitial mastitis, caused by the constriction of the ducts; but, except for the way in which they add to the size of the lobule and increase the irregularity of its outline and the hardness of its texture, they are of but little importance.

(*d*) *Retention Cysts.*—These are the largest of the simple glandular cysts; sometimes attaining the size of a small orange. They may be single or multiple, and occur at any age. Undoubtedly, they are developed from the ducts (whence their name, *duct cysts*), and not unfrequently some of their contents can be squeezed out (so that they are not all due to simple obstruction); but nothing is known as to the cause of their development. Their contents are usually clear and albuminous (sometimes colored), and many of them contain papillary growths. The diagnosis rests chiefly upon the even globular outline, and the absence of pain and of adhesions; but, especially when they are deeply seated and in a large breast, it is often impossible, owing to their hardness, to distinguish them from chronic abscess or carcinoma without an exploratory puncture. As, however, it is impossible to say from this alone whether there is an intracystic growth or not, they should always be incised, and, if they are really simple, drained or wiped out with a sponge dipped in some strong antiseptic, so as to ensure their obliteration.

(*e*) *Galactoceles* or *milk-cysts* may be caused by rupture or distention of one

of the ducts during lactation, usually in one of the early months. Sometimes there is a history of injury. The swelling makes its first appearance rapidly, and in some of the cases has varied considerably in size, increasing during the actual time of suckling, and diminishing to some extent in the intervals by condensation. Spontaneous cure does not seem to occur; the contents gradually become more and more inspissated, but the tumor does not disappear. In some instances, it has attained an enormous size.

If the tumor is of rapid growth, the child must be weaned and every endeavor made to arrest the secretion of milk. The size of the swelling should be reduced by aspiration, and the increase checked as far as possible by gentle pressure. Afterward the cavity must be drained with great care, to avoid suppuration. Small cysts, and those which show no tendency to increase, may be left until the period of suckling has expired. It is probable, however, that many of the smaller stationary galactoceles are really caseous abscesses, the contents of which are more or less dried up, and which possibly were originally of tuberculous origin. The same may be true of the calcareous masses which have occasionally been described.

### Mammary Glandular Tumor.

The mammary gland, like the parotid and thyroid, is liable to its own form of tumor. The histological elements that compose it are the same as those met with in other growths; but its features are so distinctive that, like parotid glandular tumor, for example, it requires separate description.

It originates in connection with the lobules of the breast after puberty, sometimes one element, sometimes another, being in excess. Where it is composed chiefly of glandular structures, it is known as *adenoma;* if there is a fair proportion of fibrous tissue as well (the most common form), as *fibro-adenoma*. In some cases the ducts and acini are flattened into slits; in others they are enlarged into cysts of all sizes (*cystic adenoma*). Sometimes these cysts are simple, lined with one or more layers of epithelial cells, and contain a clear gelatinous or colored fluid; sometimes there are growths of various character (adenomatous or papillomatous) inside (*proliferous cysts*). In other varieties, again, the matrix of the tumor, instead of retaining the character of firm fibrous tissue, resembles that of a sarcoma, and from this further forms arise: *adeno-sarcoma* when the gland tissue is not enlarged out of proportion to the rest; *cystic sarcoma* (sero-cystic sarcoma or Brodie's disease) when there are cysts developed from the acini or ducts filled with soft sarcomatous masses sprouting from their walls. These tumors may occur at any age after puberty; there may be only one, or there may be any number in one or both breasts; if left they may grow to any size, especially the sarcomatous forms; and at length the skin over them may give way so that they develop into gigantic fungating masses, causing the death of the patient by exhaustion; but they do not affect the surrounding lobules of the gland (except by their pressure) or spread through the lymphatics or the blood-vessels, and (though it often happens that other smaller ones grow up to replace them) they do not recur after free removal. The slow-growing fibrous forms are very common in young women; the more rapid ones rarely occur before thirty years of age; but sometimes a tumor that has scarcely made any progress for months together suddenly begins to grow, and then it may attain an enormous size. Cysts may occur at any time of life.

Fig. 508.—Cystic Tumors in Breast with Pedunculated Adenomatous Growth.

**Diagnosis.**—The distinguishing feature of mammary glandular tumors is

their mobility, especially while they are small ; they seem capable of being pushed among the other lobules in all directions. Those that grow rapidly, and are allowed to attain a large size, lose this feature to a great extent.

Adenomata and fibro-adenomata are particularly hard, and often nodular on the surface ; adeno-sarcomata are softer, growing more rapidly, and the skin over them is covered with enlarged and dilated veins. Cystic adenoma can usually be recognized by the rounded outline and the elastic sensation it gives when pressed upon ; moreover, there is not uncommonly a history of a serous or blood-stained discharge from the nipple, and sometimes the tumor has distinctly varied in size ; but it is impossible to form any idea of the character and scarcely any as to the presence of intracystic growths. They may be large or small, sarcomatous or papillary ; the fluid around them altogether conceals their rate of increase. Pain is seldom complained of in the case of the larger growths, although their weight and size may prove a serious inconvenience ; but some of the smaller and harder ones, especially those that occur in young unmarried women, are not unfrequently the seat of intense neuralgia, especially after handling and during the menstrual period. The skin never becomes involved or the nipple retracted unless the growth has attained a very large size, or has spread among the other lobules of the gland.

**Treatment.**—Excision of the tumor is always advisable. It is true that many of the smaller ones persist for a very considerable time without showing any change, but there can be no certainty of this, and not unfrequently after remaining latent for years they suddenly begin to grow at a rapid rate. The gland itself should never be removed unless the tumor is so large and so intimately fused with it that it is unavoidable ; and unless it is actually adherent, no skin need be sacrificed.

The plan of operation depends upon the size and situation of the tumor. If it is small and superficial it may be fixed between the finger and thumb of the left hand, and a single incision radiating from the nipple, made down to it and through its capsule ; as a rule it shells out readily, though sometimes a certain amount of dissection is required. If it is deeply placed, or if there are several, it is better to adopt the method advocated by Thomas, of New York, and reflect the breast upward from below, the incision being made in the groove beneath the gland so that no scar is visible. Fortunately these tumors are for the most part so freely movable in the breast tissue, that, if there are several of them, a single incision will usually serve for all. For the larger ones no rules can be laid down, but, especially if the patient is nearing middle life, and the gland tissue is much involved, it is often simpler and more satisfactory to remove the whole. Pressure should be carefully arranged afterward, so as to ensure complete obliteration of the cavity left. Whether a drainage tube should be used or not depends upon the amount of bruising.

### Sarcoma.

All varieties of sarcoma, with all their forms of secondary degeneration, are occasionally met with in the breast, but the only one at all common is the spindle-celled. It may occur at any age after puberty, and forms a soft, rounded, or lobulated mass, pushing the gland on one side, and very difficult to distinguish, at first at least, from an adeno-sarcoma. If there are cysts in it, due to softening or hemorrhage, or even if there are isolated masses of softer round-celled growth in the middle of the firmer part, the diagnosis may be impossible.

Growth at first is usually slow ; after a little while, however, the tumor begins to increase with great rapidity, and very soon it develops into a gigantic mass, which, if left to itself, ulcerates through the skin and forms a huge fungating excrescence that bleeds with the slightest touch. The only treatment is free excision, not only of the tumor, but of the capsule that surrounds it. Afterward the most careful watch must be kept. Infection of the glands or of distant organs is rare, but local recurrence is exceedingly common, and each secondary growth increases in size more rapidly than the one that preceded it. Operations may have

to be performed again and again ; sometimes at last the tendency to recurrence is overcome ; more frequently before this occurs the time arrives when surgical interference is no longer practicable.

### Carcinoma.

Carcinoma of the breast may be glandular, columnar-celled, or squamous. Of these the two last form together but a very small percentage of the whole. The columnar-celled type grows from the ducts (*duct or villous cancer*) ; it can only be diagnosed by the cystic appearance it presents on section, although its nature may be suspected if there is a blood-stained or milky discharge from the nipple ; the squamous one spreads by continuity from the areola and is sometimes secondary to Paget's disease.

Glandular carcinoma presents many different forms, according to the relative proportion of the cells and stroma that compose it. The more rapidly-growing varieties as a rule occur in younger patients with full breasts, but there are many exceptions.

(*a*) *Atrophic Scirrhus.*—This is the hardest and slowest in its growth of all : the contraction is so extreme that the breast grows smaller and more withered the longer it lasts, and the skin and the surrounding structures become bound together as if by dense cicatricial tissue. It is usually met with in thin, wasted breasts of old people, and it may last many years before it proves fatal ; when it is cut across it creaks and grates before the knife ; the surface becomes markedly cupped, but there is little or no cancer juice. Its color is grayish white, with streaks and dots of yellow, and it has no outline, but shades off imperceptibly into the healthy tissues around.

(*b*) *Nodular Scirrhus.*—The wasting is much less, so that, although the contraction of the stroma renders the swelling intensely hard, it is not sufficient to cause a diminution in size. There is a distinct hard nodule which can be felt as an addition to the breast gland when the palm of the hand is laid flat upon it. The cut section is much the same as the former, but it is more juicy, and the fibrous bands that traverse it are not so inextricably welded together.

(*c*) *Infiltrating Scirrhus.*—This differs not only in the rapidity of its growth and the absence of wasting, but in the peculiar mode of its extension ; it seems to spread, not by gradual continuity of structure, but by leaps and bounds, and so quickly that it may even seem to originate in many separate points at the same time. Its course, so far as life is concerned, is proportionately fatal. There are two varieties of it, according to whether it involves the glandular tissue or the skin. In the former the whole breast rapidly becomes enlarged ; no definite tumor can be felt ; the nipple is buried by the increased growth around it as much as by its own retraction ; and the whole gland is converted into a solid mass of carcinoma. In the latter the skin is chiefly involved ; it becomes peculiarly hard, thick, dense, and coarse (it has been compared to a pig-skin saddle) ; the color changes to a dusky red ; the texture is completely altered ; it does not move on the parts beneath, and it cannot be pinched up into folds. Minor degrees of this are often seen over a carcinoma as it approaches the surface, but in this particular form the disease may spread all round one side of the thorax (*cancer en cuirasse*), and invest it with an absolutely rigid casing within the space of a few weeks.

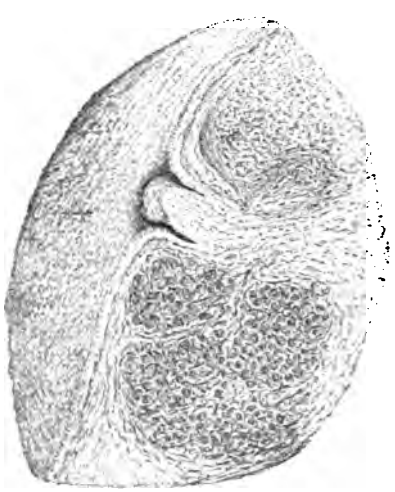


Fig. 509.—Scirrhus with Retracted Nipple, undergoing Colloid Transformation.

The cut surface, owing to the softness and rapidity of growth, often does not cup at all; but the cancer-juice on scraping is very abundant.

(*d*) *Encephaloid.*—Very soft glandular carcinoma, such as occurs in the testicle, for example, is seldom met with in the breast; many of the cases formerly described as such were in all probability sarcomata; but the softer infiltrating forms are sometimes termed encephaloid, from the striking contrast they present to the hardness of scirrhus. As a rule their growth is even more rapid than that of the preceding one.

In addition to these *cystic carcinoma* has been described (the cysts being due to hemorrhage or softening); and occasionally *colloid degeneration* is met with; but though this form of carcinoma is peculiar from the length of time it often lasts, it is not a distinct variety.

**Etiology.**—Cancer in the breast is very rare before thirty years of age; then it becomes more and more frequent until nearly fifty; after that it begins to diminish again (not only absolutely, but relatively to the number living); but it may start even in extreme old age. Marriage, child-bearing, suckling or not, and disorders of menstruation have never been proved to have any relation to it. It occurs in all social conditions, and in those who have enjoyed perfect health as much as, and possibly even more than, in others. It may follow a blow, though, of course, too much reliance must not be placed upon ordinary histories; and in a small proportion of cases it follows on chronic lobular induration, or develops in the neighborhood of an old abscess. Whether locality or climatic conditions have any effect is very uncertain, and, probably, owing to the freedom of communication at the present day, will never be proved. Statistics show that it is not hereditary, but as individual cases of the most striking character are met with from time to time, it is probable that this statement is too sweeping, and that the tendency exists, though it may not be marked, and may require other circumstances for its development. It is an old observation that carcinoma rarely develops during pregnancy or lactation; and it has been said that a tumor that makes its appearance during either of these periods is almost certainly not cancer; but the symptoms at its first commencement are so exceedingly slight, and the changes through which the gland tissue passes are so extensive, that this is very difficult to prove.

**Symptoms.**—These naturally present considerable variety, but essentially they may be reduced to two.

1. The presence of a tumor. Unfortunately, this fails to distinguish commencing scirrhus from chronic lobular induration, as in both there may be an actual diminution in size.

2. The way in which the tumor infiltrates and (like a crab that has been turned upon its back) drags toward itself everything round. The same thing is true, though to a less extent, of chronic abscess, and this renders the difficulty of separating one from the other so great.

The first appearance of scirrhus is an ill-defined, intensely hard nodule in the substance of the gland. There is no margin; it cannot be separated from the lobules around it or moved freely in any direction. Whether, when the hand is laid upon it, it feels like an addition to the gland or not, depends upon the relative amount of new growth and contraction. In a little while it becomes more definite. If it is near the skin this is dimpled over it, the vertical septa of connective tissue and the deep ends of the cutaneous glands being dragged down first; the nipple (if it is near one of the larger ducts) is treated in the same way (often this can be best seen by gently pulling the growth to one side); and even the fascia beneath the gland is caught as well. Soon some of the intercostal nerves are involved, and then it gives rise to the most intense pain, sharp and stabbing, especially at night and when the breast is handled, sometimes limited to the gland, but more often spreading round the thorax, over the shoulder, or down the arm. In a little while the tumor grows more prominent, still retaining its extreme hardness; the skin is bound down over a wide area and becomes a dusky red; the lymphatic glands in the axilla are enlarged; the nipple is perhaps entirely with-

drawn; and by-and-by a small fissure makes its appearance about the centre of the swelling. At first this is covered by a scab of dried epidermis; soon this falls off and a typical scirrhous ulcer is left, with a pale, waxy base, and raised, hardened, and rolled-in edges.

The subsequent course is of the same character. The patient's health begins to fail, although it may be some time before there is a definite appearance of cachexia. The ulcer steadily increases in size; if the cancer is soft and of rapid growth it may fungate and bleed; more often it merely melts away on the surface, giving off a discharge of a peculiarly offensive description. The axillary glands become matted together; the veins and lymphatics are closed; œdema of the arm sets in; the brachial plexus is compressed, causing the most intense neuralgia; then the supra-clavicular glands are attacked; pleurisy perhaps follows (the lymphatics from the inner half of the breast communicate freely through the intercostal spaces with those of the mediastinum and the pleura); and finally secondary deposits make their appearance in the liver, lungs, vertebræ, or other parts of the body.

The relative prominence of these symptoms differ, of course, very greatly. In some the rapidity of the growth is the chief feature: a soft, elastic, almost fluctuating swelling seems to take the place of the breast almost at once. In others the skin is the part attacked, the extreme form being that known as *cancer en cuirasse*. In a third class again ulceration begins before there is much growth, and persists, quietly spreading year after year. The pain, the implication of the skin, the retraction of the nipple, and the fixation to the pectoral beneath (best seen when the muscle is in action) depend largely upon the accidental position of the growth; and so, to some extent, does the direction in which lymphatic infection spreads.

**Diagnosis.**—When the skin is involved, the nipple retracted, and the axillary glands enlarged (the stage at which the majority of the patients present themselves for treatment) the diagnosis is easy, but too late. If there is to be any hope of definitely curing a patient suffering from cancer of the breast, the diagnosis must be made before any one of these three is present.

In the case of scirrhus the chief difficulty occurs in connection with *chronic lobular mastitis*, *chronic abscess*, *fibro-adenoma*, and *deep-seated cysts*. The softer varieties are frequently not distinguishable from *adeno-sarcoma*, *cysto-sarcoma*, or *true sarcoma*, but this is less material, as in either case free and early exploration is the rule.

The following are the most important points:—

(*a*) *Age.*—Carcinoma is very rare before thirty, and rare before thirty-five years of age; the other affections may occur at any time of life.

(*b*) *Fixity.*—Unfortunately, chronic abscess and chronic induration are as adherent to the lobules around as scirrhus; and in any case, when the growth is small and deeply seated in a full breast, this is most difficult to estimate.

(*c*) *Consistence.*—Scirrhus is of stony hardness, the others are not; but the difference is often inappreciable. A cyst near the surface is tense and elastic, chronic induration is often very irregular in its outline, and œdema is not unfrequently present over a chronic abscess.

(*d*) *Period of Origin.*—Chronic abscess is said to occur most frequently during lactation or after a miscarriage. This is not the case with carcinoma, although it is impossible to deny that it may happen.

(*e*) *Multiplicity.*—If there are several nodules, especially if they are at some distance from each other (so that they are not caused by latent extension), or if there is a symmetrical induration in the other breast, it is strongly against carcinoma, and in favor of chronic mastitis.

(*f*) *Shape.*—This is of little service; but if the swelling is tense and globular, or if one or more globular enlargements can be detected on it, it is almost certainly cystic, in part at least.

(*g*) *Tenderness* is very important. In chronic induration the lobe is nearly always very tender on pressure, or on trying to separate it from the rest of t

gland; carcinoma, on the other hand (in the early stage) is tolerably insensitive. This is often shown by the way in which the nodule is discovered; in the one case the tenderness attracts the attention of the patient, in the other it is the presence of a hardened lump.

(*h*) *Pain.*—The pain of carcinoma, when it once begins, is nearly always described voluntarily by the patients as sharp and stabbing. That of chronic induration is often severe after handling (especially in women too young for scirrhus), but it is neuralgic in character; there are neuralgic points down the axillary line on the side of the thorax where the nerves perforate the intercostal muscles, and it varies in intensity at each menstrual period. Sometimes the patient is positive that the size of the suspected lobe varies too.

(*i*) *Dimpling of the Skin.*—The skin is adherent over inflammatory swellings, and sometimes over large, rapidly-growing tumors, other than carcinoma, but the dimpling of scirrhus is different. At the first it is due to the dragging on the suspensory ligaments of the breast, which pass vertically inward from the surface; later the ends of the cutaneous glands are involved, and then the subcutaneous tissue and the skin itself. This stage is of very great importance, not so much for the diagnosis of the disease, but as a criterion of the extent to which it has spread—practically it may be taken that the lymphatics are involved as well, whether they can be felt or not.

(*k*) *Retraction of the nipple* is to a large extent a question of locality; if, that is to say, scirrhus develops near its base, retraction appears very early; if, on the other hand, it is far away, very late. It is due to the dragging upon the larger ducts, and it may arise from many other causes besides scirrhus. It may, for example, be congenital, or it may be the result of inflammation, past or present; or it may be due to some other form of tumor pressing the ducts upon one side, or causing uneven enlargement of the gland. Retraction, therefore, is not distinctive, but when it occurs in connection with an indurated lobule, before this has attained any size, its presence is highly significant.

Finally, if the diagnosis is in the least degree doubtful, an exploratory puncture should be made under an anæsthetic, and if this is not satisfactory a free incision with full permission to proceed further, if it is thought advisable.

**Prognosis.**—The duration of life, in cases of cancer of breast that are not operated upon, is under three years on the average of a large number, but individual instances vary very greatly. The soft and rapidly infiltrating growths, and especially those which implicate the skin to a large extent, may prove fatal within six months; atrophic scirrhus, on the other hand, may last for ten and even twenty years unchanged. Death may be due to exhaustion, septicæmia from the absorption of the foul discharge, or to the occurrence of secondary deposits. Hemorrhage from the surface of the sore, or pleurisy due to direct extension along the lymphatics, is not unfrequently the immediate cause.

**Treatment.**—Cancer of the breast can only be cured by complete incision at the very earliest moment; it can, it is true, be removed by caustics, but the process is slower, more painful, and absolutely uncertain. Whether an operation is to be recommended or not depends upon (*a*) the condition of the patient; (*b*) the character of the breast; (*c*) the nature of the growth; and (*d*) the stage it has reached.

(*a*) *The Patient.*—In this the surgeon must be guided by the ordinary rules for operating. Excision of the breast is a very favorable operation (so far as immediate results are concerned—the older statistics are quite valueless), if the patients are properly selected; primary union is the rule, but no operation should be undertaken in cases of renal disease, diabetes, advanced pregnancy, cirrhosis of the liver, or extreme obesity, especially if associated with shortness of breath and a tendency to bronchitis. Age of itself is no bar.

(*b*) *The Breast.*—The larger the breast, whether due to the gland itself or to an accumulation of fat around it, the more unfavorable the operation in every way; the wound is larger (in some cases the gland has outlying lobules under the margin

of the pectoral muscle), complete removal is more difficult, the growth is almost certainly not of the nodular or atrophic variety, lymphatic enlargement is more difficult to detect, and if there is a thick layer of fat the wound does not heal so well.

(*c*) *The Nature of the Growth.*—At one extreme are the very chronic cases, at the other the rapidly infiltrating ones. With regard to the former, it is sometimes questionable whether operation is advisable—the expectation of life without its being done is so much better than in the other varieties; on the other hand, there is the certainty that ultimately it will prove fatal; and the possibility, with but slight risk (for these cases are very favorable ones), of freeing the patient from a ceaseless source of anxiety and pain. With regard to the latter, it must be admitted the results are exceedingly bad; it seems impossible to operate soon enough, and the actual prolongation of life is very short. Whether, when the absolute importance of early operation, even in suspicious cases, comes to be more widely recognized the results will be improved upon, especially if the axillary glands are removed as well, remains to be seen.

(*d*) *The Stage the Growth has Reached.*—If complete excision is performed before there is any dimpling of the skin or retraction of the nipple, prolongation of life is certain (taking, of course, into consideration the risk of the operation), and freedom from recurrence highly probable, especially if the growth is one of the harder kinds. It is for this reason that it is so important to advise an exploratory operation in every case of chronic induration of the breast, in a patient nearing forty years of age, if the diagnosis is in the least doubtful.

If the skin is dimpled, relief may be promised, and (almost certainly) local recurrence prevented again under the same conditions (complete excision, and one of the harder varieties); but absolute cure is much more questionable. In such a case it is impossible to prove that the axillary glands are not involved, and consequently the whole of the loose cellular tissue and the lymphatics that cover the mammary portion of the pectoral muscle and fill the axilla, must be systematically dissected out. The fact that the glands cannot be felt means nothing.

Some advise that this precaution should be adopted in every case of carcinoma, and refuse the term "complete" to every operation in which it is not done. Undoubtedly it increases the patient's chance of ultimate cure; and, accordingly, where it does not too much increase the immediate risk, it should be practiced.

In the later stages, when the skin is extensively adherent, and the glands are definitely enlarged and perhaps matted together, it must depend entirely upon the patient. Cure is very doubtful; relief from pain, and from the prospect of an intensely offensive and perhaps fungating ulcer, is fairly certain (provided the whole of the affected skin can be freely removed), but no more, and often the shock necessarily attendant upon such an operation (even when primary union is assured) seems to make the disease light up elsewhere and grow with redoubled vigor. If the supra-clavicular glands are involved; if the breast is adherent to the chest wall (not the pectoral muscle, but the fascia near the sternum), so that there is reason to apprehend the speedy onset of pleurisy; if there is œdema of the arms, or if nodules are perceptible in the liver or elsewhere, operations are not advisable unless there are definite local reasons for it, such as intense pain or imminent hemorrhage.

**Recurrence.**—Unhappily, this is the rule. The average time seems to be about a twelvemonth. It may take place locally, in the cicatrix or near it (sometimes in the scars left by the sutures), or in the axilla. The question of further operation must be determined by the same consideration as in the previous case; permanent cure is, it is true, probably not to be hoped for, but, with very small risk and suffering, it is sometimes possible to enable a patient to live with a fair amount of comfort and without pain until visceral lesions make their appearance.

The **treatment** of carcinoma of the breast, if operation is declined, is very unsatisfactory. Arsenic in continually increasing doses has been recommended,

but it has not been proved to have any real influence. Cold lead lotion checks the growth a little by reducing the hyperæmia, but it must be kept up continuously; poulticing makes it increase at a furious rate. Chloride of zinc with opium and starch paste appears to be the most efficient caustic, strips of lint soaked in it being inserted in linear incisions made through the superficial layer, after the skin has been destroyed with nitric acid. After ulceration has set in, the surface must be kept clean and free from putrefaction by means of unirritating antiseptics. Salicylic acid and resorcin have been used as local applications, but they can have no influence upon lymphatic extension. Opium is the only drug that relieves the pain, and for this it must be given in full and increasing doses. Life is not sufficiently prolonged for the evil effects of continued opium-taking to deserve consideration.

## DISEASES OF THE MALE BREAST.

Inflammation may occur at infancy and occasionally later in life, but it is nearly always periglandular and rarely ends in suppuration. Carcinoma may occur, but other forms of new growth are very seldom met with. The treatment presents nothing special.

### Excision of the Breast.

In cases of carcinoma it should be the rule to remove the whole gland, the nipple, the skin for a wide distance over the tumor, the fascia covering the mammary portion of the pectoral muscle, the lymphatics running up from this to the axilla, and to clear this space out thoroughly and systematically. If the operation is performed before the glands are enlarged, or while they are still small and isolated, there is little difficulty in accomplishing this; if they are already matted together and to the surrounding structures, the operation becomes at once one of a very serious character. Mitchell Banks, Jacobson, and others, recommend that the pectoral muscles should be divided, completely if necessary; the axillary vein ligatured above and below and cut away, and even more sweeping measures taken, if there is the least suspicion as to the thoroughness of removal. It may be noted that ligature of the vein, even when all the axillary lymphatics are cleared away as well, merely causes transient œdema.

The patient is prepared in the usual manner; the axilla shaved and thoroughly cleansed; the arm moderately abducted from the side; and the rest of the body and the opposite side of the chest well protected with mackintoshes. The incision depends to some extent upon the situation of the tumor; an elliptical one, running upward and outward to the axilla, is usually recommended; but, in many instances, one shaped like an italic *f* placed horizontally ⌣ answers better; it keeps the line of the cicatrix well out of view; it can be carried up readily along the border of the pectoral muscle to the axilla, and, owing to the shape of the breast, it allows a greater amount of skin to be removed without sacrificing immediate apposition of the edges of the wound.

The assistant stands on the opposite side. The lower incision is made first, and a flap of skin and subcutaneous tissue reflected from off the gland until its margin is reached and the edge of the pectoral exposed. The upper incision is then made in the same way; or, if the gland is a small one, the pectoral fascia with the structures lying on it is stripped up at once from the muscle until the opposite border of the breast is reached. As soon as this is done the surgeon, holding the gland in his left hand, divides the skin over the upper hemisphere, and with a few touches of the scalpel sets the whole structure free, except at the upper and outer angle; this part must be carefully preserved, as it contains the majority of the lymphatics and acts as a guide to the axilla.

Hemorrhage may occur from the incisions in the skin or from the branches of

the internal mammary artery coming through the pectoral muscle in a vertical direction. The bleeding points should be covered at once with a sponge, and hæmostatic forceps applied. Ligatures are seldom needed.

The surface of the wound must then be carefully examined to see that the whole of the gland has been removed, and that no subjacent fascia is left behind (if the muscle is involved, the fibres should now be taken away); and if the skin will come together with the arm in a position of abduction, the sternal end of the wound may be washed out with a hot solution of corrosive sublimate and united as soon as the hemorrhage has been stopped. If this is not practicable, it should be carefully covered over with hot sponges, to avoid the chilling effect of exposure.

The arm is then completely abducted; the incision carried along the lower border of the pectoralis major nearly up to the biceps, the fascia divided, and the contents of the axilla dissected out, beginning at the pectoralis major, removing the fascia for some little distance between it and the pectoralis minor, and then working under this until the apex is reached. If there is the least difficulty, there should be no hesitation in dividing these muscles at their insertion as far as may be required. The intercosto-humeral nerves are divided and some branches of

FIG. 510.—Esmarch's Operation for Excision of the Breast.

the long thoracic and other arteries cut, but there is very little hemorrhage. If, when approaching the axillary vein, or, what is nearly as important, the end of the sub-scapular, it is found the glands are extensively adherent, it is better to pass ligatures beneath the vessels and give them to an assistant to hold without tying them. In this way hemorrhage and the risk of air entering in can be easily avoided. Where structures require dividing high up, pressure forceps should always be applied first.

The axillary wound is then thoroughly sponged out with hot lotion in the same way: all hemorrhage stopped: a final examination made to see that the axillary boundaries are really clear, and the arm brought down to the side to allow the edges to be approximated.

Owing to the irregularity of its shape, a thick and wide drainage tube is always required for the axilla. The sternal end of the incision, on the other hand, unless the patient is very stout, may be left without. Three or four deep sutures of adjustment may be required to take off tension, but it is surprising how a wound that gapes widely when the arm is abducted, falls together as soon as it is placed by the side. If there is not sufficient skin, the surface should be thoroughly cleansed with corrosive sublimate, dusted lightly with iodoform, and covered with a piece of protective cut the exact size.

Afterward the skin of the arm and the axilla should be thoroughly dried, and the whole space, behind the shoulder, under the arm and along the thorax, carefully packed with loose pieces of some absorbent dressing. The elbow must be supported; the arm fixed to the side; the hand laid on the thorax, and the whole enclosed in a linen binder. As a rule, the wound drains better if the patient lies upon the sound side; but as this may be inconvenient, or cause the injured one to move too much with respiration, this should not be insisted on. The drainage tube, if there is any oozing, must be cleared the next day; if the wound is really dry, it may be left till the second or third. The patient should on no account be allowed to sit upright, or move the arm until the axillary wound is practically sound.

# CHAPTER XXVII.

## *AMPUTATIONS.*

### Amputation of the Limbs.

Amputation may be required for injury or disease: and the former may be *primary* (within twenty-four hours), *intermediary* (before suppuration), or *secondary* (after suppuration). But this division is of doubtful value. It is more important to distinguish those cases in which inflammation has not yet occurred from those in which it has already broken out (and the operation is performed with the view of saving the patient from acute septic poisoning), and from those in which the tissues have recovered and are beginning to protect themselves by throwing out a barrier of granulations.

The chief points in planning an amputation are: (1) to sacrifice as little as possible; (2) to provide an ample covering of skin; (3) to arrange the flaps so that their weight shall keep them in position; (4) to make sure there is free exit for any fluid that may accumulate; and (5) to keep the scar away from the line of pressure.

The various methods can be reduced to three: (*a*) the circular; (*b*) the old flap operation, in which all the tissues down to the bone are included; and (*c*) the modified flap operation, in which the covering is formed of skin alone, all the other structures being divided on a level with the end of the bone.

(*a*) *The Circular.*—The limb is divided by a succession of circular sweeps: the first through the skin; the second (after the skin has been retracted) through the superficial muscles; the third through the deep ones and the periosteum; and the fourth, when all the tissues are drawn back, through the bone. It is practically limited to the arm; it cannot be used over conical parts (as the skin cannot retract), or where the bone would lie in the centre of the stump, as then it would abut upon the cicatrix. If the limb is injured on one side only, it may be very wasteful; and in cases of disease in which the tissues are hard and brawny, or the skin tied down by adhesions, it is impracticable. Where it can be performed the covering of skin is good, without much muscle, drainage is satisfactory, and the scar very small.

(*b*) *The Old Flap Operation.*—This may be performed either by transfixion, cutting from within outward, or by dissection, separating the soft tissues from the bones in an upward direction; and the flaps may be antero-posterior, lateral, and equal in length, or one may be much longer than the other. With the exception of one special modification (Teale's amputation), the old operation is seldom performed on any part but the extremities: the flaps are heavy and thick, containing a large amount of muscle; the vessels may easily be slit, or wounded higher up than they are divided; the surface of the wound is very large; and the nerves are contained in the flaps.

In Teale's amputation (which is reserved almost entirely for the lower third of the lower limb), the anterior flap, which contains all the tissues dissected up from the bones, is perfectly square, equal in length and breadth to half the circumference of the limb at the spot at which the bones are to be divided. The posterior flap is of the same breadth, but only one-fourth the length. The bones are divided at the line from which the flaps spring, and the long flap folded round the end, and united behind it to the posterior one, the cut surfaces facing each other. The flaps are measured out and marked down first, and the two lateral incisions made before the transverse ones. The drainage is admirable and the stump left very soon becomes serviceable, if care is taken to keep the

larger vessels and nerves in the shorter flap: in any other part of the body it is much too extravagant.

(*c*) *The Modified Flap Operation.*—In this, one flap (or sometimes both) is formed from the skin and subcutaneous tissue only; the rest of the structures are divided by a circular sweep at the same level as the bone. It is a method capable of far wider application than any other, and may be modified in a number of different ways.

In Carden's operation, for example (which, though first devised for the knee, may be employed in many other parts), a rounded or semi-oval flap is reflected from the front of the limb, and everything else divided down to the bone, this being sawn through slightly above the plane of the muscles. This leaves an almost flat stump, covered with integument; the edges of the wound are dependent, and the cicatrix lies well out of the way. In other cases (amputation of the forearm, for instance) both flaps may be formed in this way, of equal length or not, according to the amount of tissue available; or lateral flaps may be cut, as in the leg, or a kind of hood dissected up, as in Stephen Smith's method.

The position of the surgeon in performing an amputation is always such

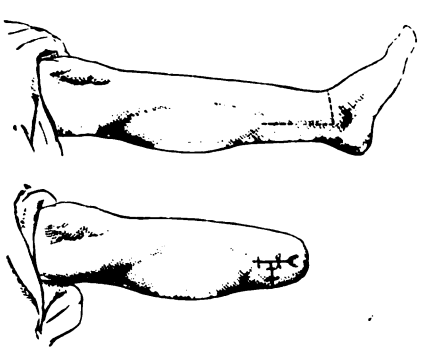


FIG. 511.—Teale's Amputation.

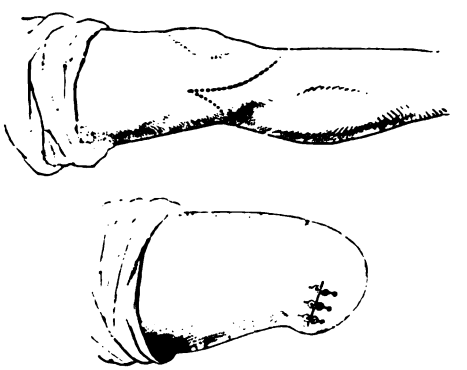


FIG. 512.—Carden's Amputation with Short Posterior Flap.

that he can raise the flap with his left hand, without crossing with the right; usually, therefore, he stands on the right-hand side of the limb. The number of assistants required depends naturally upon the part to be removed; one holds the limb, and afterwards supports the stump in a convenient position; another assists the surgeon in retracting the flaps, sponging, and tying vessels; and a third may be required to control the main artery. Where it is possible the patient should be carefully prepared; the bowels opened; the urine examined; the pulse, respiration, and temperature noted; and the limb thoroughly cleansed, and if necessary shaved. The last meal should be a light one and three hours at least before the operation. The anæsthetic, of course, requires a special assistant.

During the operation the bed should be thoroughly warmed, and hot bottles, pillows, etc., arranged, so that the patient may be placed in a comfortable position at once, with the stump slightly raised and secured against any accidental movement or spasmodic contraction of the muscles. Unless the patient is thoroughly covered up, the loss of heat during an operation (especially under ether) adds seriously to the shock.

... TIONS.

... AND SCAPULA.

... ...ued at intervals for a great many ... performance until Berger's Moto... ... Parkes, of Chicago, after exper... ... ...ments on the living subject in 1... ... an article before the Chicago Med...

... ...ork in a late issue of the *Ann...* ... ...ticle, I have looked through all the ... ...ical method given. It remained ... ...ed to the plan he suggests after ... ...quickest and easiest method of doing the ... ...ed according to his plan of procedure ... ...outer extremity of the clavicle outward ... ...lifts the clavicle and turns it out of the ... ...ds closed so that they are easily secured ... ...ast experience, that as the front of the axilla ... ...be seen a ridge across it produced by ... ...external thoracic nerve. It is easily found ... ...ing outward and this nerve leads directly to the ... ...ry muscle to them. With the clavicle ... ...ated, easily isolated, and free from di... ... ...ted in two places, an inch apart, and ... ...the circulation is absolutely under control. May ... ...that the arm should be elevated for a few ... ...from it, thus saving as much blood as ... ...use I applied the Esmarch bandage ... ...ained in this position, by a rapid ... ...ly divided and the pectoralis major and ...

... ...ne in this way: Commence at the ... ...the knife directly across the anterior part ... ...ver angle of the scapula; then from the outer ... ...the knife behind the joint to the same ... ...ether all the muscular attachments should ... ...without any trouble. This gives a per... ...coming together easily and nicely, and ... ...anterior part of this wound which was ...

... THE SHOULDER JOINT.

... ...ful as in case of doubt it enables the ... ...the least disturbance. The subclavian must be ... ...is often a difficult proceeding, the vessels ... ...agent or his assistant, or isolated and secured ... ...patient is semi-recumbent, with the shoulder ... ...ine and the arm moderately abducted. ... ...outside the coracoid process to the insertion of ... ...must be divided. The incision is then carried ... ...of the arm to the posterior border of the axilla ... ...inferior incision, from the same point to join the for... ...may be marked out now, but it must not be deeper than ... ...cut the capsule, the tendons attached to the inter...

osities, and the long tendon of the biceps divided by cutting on to the bone; the limb disarticulated and the soft structures on the inner side cut through, the artery being either secured by an assistant, or exposed and ligatured before division. The axillary and the anterior circumflex are the only vessels necessarily cut.

In cases of malignant disease; in which it is wished to retain as little of the

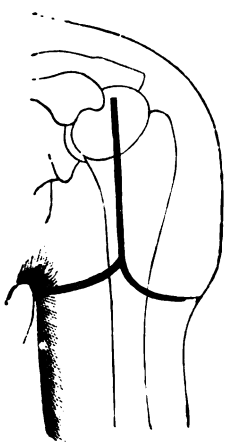


FIG. 513.—Spence's Amputation.

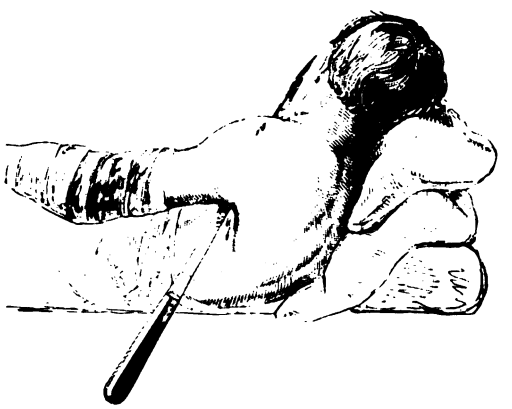


FIG 514.—Amputation by Transfixion.

soft structures as possible, skin flaps may be used instead. Lateral ones are marked out: (*a*) by an incision beginning in the middle of the axilla, passing down nearly as low as the insertion of the deltoid on the outer side of the arm, and then curving upward to end just outside and below the coracoid process; and (*b*) by a second beginning and ending at the same points, only passing a sufficient distance down the inner side of the arm. Or a racquet-shaped incision may be employed, start-

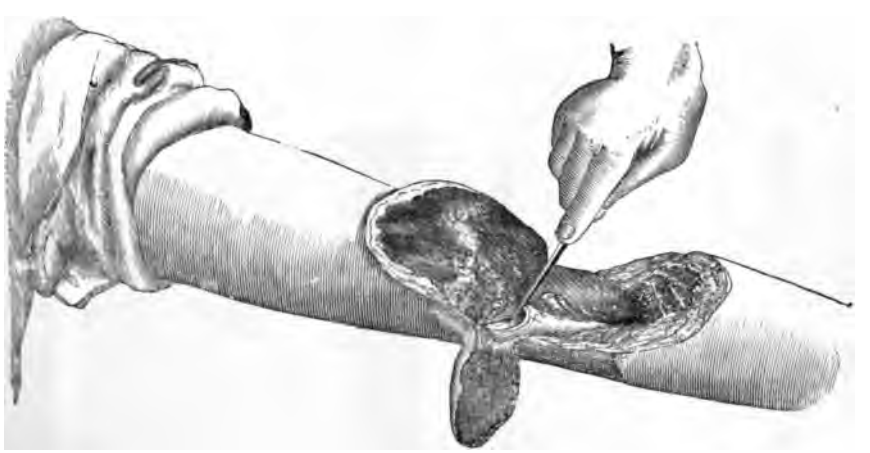


FIG. 515 —Amputation at Elbow Joint.

ing from the same point near the coracoid, and running first down the outer side of the arm and then circularly round it. In either case the skin is dissected up, the soft parts divided, and the vessels secured as before. In this method the posterior circumflex is usually divided as well as the anterior.

Other methods are by transfixion from behind forward (or *vice versa*, according

grasped with the forceps in the middle, and is drawn along the tunnel as the forceps is withdrawn. After this has been done the rubber tube is cut in two at the point where it was grasped by the forceps. With one-half of the tube the anterior segment of the thigh is constricted sufficiently firm to completely interrupt both the arterial and venous circulation. Prior to constriction, the limb is rendered bloodless by elastic compression, or by keeping it in a vertical position for a few minutes, or both of these methods are combined in preventing unnecessary loss of blood. The elastic constrictor is either tied, or, still better, after having secured the necessary constriction both tubes are caught and held by a strong pair of forceps at a point where they cross each other. The posterior segment of the thigh is constricted by the remaining rubber tube, which is drawn sufficiently tight behind, when the ends of the tube are made to cross each other and are brought forward and made to include the anterior segment, when they are again firmly drawn and tied, or otherwise fastened, above the first constrictor. As the anterior segment of the thigh contains the principal blood-vessels this method of applying the posterior constrictor furnishes an additional security against hemorrhage from the large vessels when divided by the circular incision.

*Cutaneous Flaps.*—Muscular flaps should be avoided in all amputations at the hip joint. Inclusion of muscles in the flaps is often accountable for incomplete removal of malignant or infective disease for which the amputation is made. An ideal stump can be made by cutaneous flaps and circular section of the muscles. If the conditions permit it, a long oval anterior and short posterior skin flaps should be made. If this is impracticable healthy skin must be obtained by making long external and short internal flaps, or a long posterior or short anterior, according to the location and extent of the disease. The long anterior and short posterior flaps are best adapted for a useful stump and efficient drainage. In making the anterior flap the incision is commenced at the lower terminus of the straight incision, dividing the tissues down to the muscles; it is carried downward in a gentle curve across the anterior aspect of the thigh, embracing about two-thirds of the circumference of the thigh; it is finally carried upward to a point on the inner side just below the opening in the skin occupied by the constrictors. The posterior flap is made in a similar manner, but about one-third shorter. The flaps are now reflected to the point where the muscles are to be divided, and should always include the deep fascia. The flaps are to be held out of the way, while the operator completes the amputation by dividing the muscles with an amputating knife. This last incision will correspond to a point on the femur to where the bone has deen deprived of soft parts. The incision through the muscles should be slightly conical with the apex of the cone directed upward and corresponding to the location of the tube made by the enucleation of the femur.

The sciatic nerve is now resected to the extent of an inch or more, and the femoral artery or arteries tied with catgut in the usual manner. The femoral artery and vein are now isolated, and a second catgut ligature, including both of these vessels, applied half an inch higher up. In this manner the vein is ligated, while the artery is secured by a double ligature, which places the end of the vessel in the best possible condition for definitive closure and cicatrization. The intermuscular septa are now examined, and any vessels that can be seen are tied. While the posterior constrictor is removed the posterior half of the stump is firmly compressed by applying a hot moist compress of aseptic gauze, over which manual pressure is made for a short time, for the purpose of diminishing parenchymatous oozing. After removal of the compress additional bleeding vessels are secured. The anterior part of the amputation surface is treated in a similar manner; after the removal of the anterior constrictor but few, if any, additional ligatures will be required here. The double constrictor presents many advantages in the prevention and treatment of hemorrhage in this amputation. Slipping of the constrictors is an impossibility, and they control the hemorrhage absolutely, while their proper use divides the wound into two halves, each of which is separately treated, thus reducing the loss of blood to a minimum. I applied this method to one case recently, and every one present was favorably impressed with the ease with which the hemorrhage was controlled during the amputation, and astonished at the small amount of blood lost after the removal of the constrictors. As this method of amputation does not require the presence of a skilled assistant, it will prove of special value in emergency cases. The operation can be performed with instruments contained in every pocket case. Should an elastic tube not be at hand the constriction can be made in the manner described by substituting for it a cord made of sterilized gauze or bandage.]

### Amputation Through the Femur.

(*a*) In amputations through the shaft, the mixed method (an anterior skin flap with a shorter posterior one by transfixion) answers so well, that any other is

seldom needed. Care must be taken not to slit or prick the artery as it is passing out of Hunter's canal, and, in arranging the dressings, it must be remembered that, owing to the rotation of the thigh, the flaps very soon assume a lateral position.

(*b*) Amputation through the condyles may be performed according either to Carden's or Stokes's method. The section of the bone in the former runs through the base of the condyles, and the anterior flap passes across the limb midway between the apex of the patella and the tubercle of the tibia; in the latter, the bone is divided above the condyles (supracondyloid), and the anterior flap reaches down to the tubercle, the increased length being required by the patella, the sawn surface of which is removed, so that it may face and become adherent to the cancellous tissue of the femur. They are both far superior to amputation through the thigh, owing to their enabling the pressure to be borne (in part at least) on the face of the stump and their preserving the insertion of the adductor, and, in Stokes's, the extensor muscles. Gritti's amputation is similar to Stokes's, but the bone is divided half an inch lower, and the patella does not fit so well. In Carden's operation there is no posterior flap at all; in Stokes's it is nearly as long as the anterior, and is cut either by dissection or transfixion, according to the bulk of the limb.

### Amputation through the Knee Joint.

Stephen Smith's is the most satisfactory, as antero-posterior flaps require to be of such length (both on account of the depth of the femur and the tendency of

Fig. 522.—Stephen's Smith's Method of Amputating.

Fig. 523.—Posterior Aspect of Stump after Stephen Smith's Amputation at Knee Joint, showing Cicatrix.

the posterior one to retract) that there is always danger of sloughing. The stump (which includes the patella) is of excellent shape, and well calculated to bear weight.

The incision commences one inch below the tubercle of the tibia, runs curving downward with a wider sweep on the inner side than the outer, owing to the

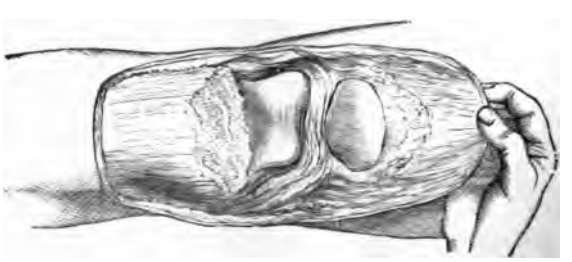


Fig. 524—Amputation through Knee Joint by Long Anterior Flap (*Erichsen*).

greater depth of the inner condyle, over the side of the leg to the middle line behind, and then upward for about three inches and a half to the centre of the popliteal space. A similar flap is shaped from the other side; the skin and fascia are reflected upward; the ligamentum patellæ divided; the joint opened, and the soft part separated by a circular sweep round the limb. It is recommended to leave

the semilunar cartilages attached to the femur, as they prevent retraction to some extent. This operation does not enable the suprapatellar pouch to be dealt with in any way, and accordingly is better suited to cases of injury than of disease.

### Amputation through the Leg.

In the upper half, Stephen Smith's method, or that in which lateral flaps are combined with circular division of all the subjacent tissues, gives the best result; but, particularly in cases of injury, it may be advisable to adopt others. In sawing

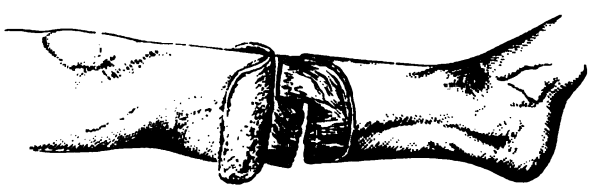


Fig. 525.—Amputation of the Leg by the Mixed Method.

Fig. 526.—Stump after an Amputation of the Leg by the Mixed Method.

the bones, care must be taken to divide the fibula before the tibia, and to remove the sharp angle left by the crest of the latter, for fear of its causing undue pressure.

The lower half of the leg is the favorite situation for Teal's amputation.

### Amputations at the Ankle Joint.

The most important are those known by the names of Syme, Roux, and Pirogoff.

*Syme's.*—The whole of the foot is removed with the malleoli, and the stump covered with a flap formed from the heel. The incisions are: (1) from the tip of the external malleolus across the front of the ankle joint (very slightly convex

Fig. 527.—Syme's Amputation of the Foot.

Fig. 528.—Roux's Amputation.

downward) to the corresponding point (half an inch below and behind the internal malleolus) on the inner side; and (2) between the same points across the sole of the foot, slanting slightly backward on to the point of the heel. On the left foot the incisions are begun on the inner side.

The ankle is supported on the edge of a form cushion at a suitable height and the fore part of the foot held by the operator's left hand in a position of extreme

dorsal flexion. The plantar incision is made first, carrying it right down to the bone (the knife is short and stout); then, the grasp being altered so as to place the foot in extreme plantar flexion, the dorsal one, taking care not to cut on to the astragalus (or still more the joint in front of it), but to open the ankle joint at once. The foot is now depressed more and more; the lateral ligaments divided; the upper surface of the os calcis exposed, and then the tendo-Achillis. This is separated from its insertion with the point of the knife, taking care not to button-hole or score the flap, and with a few touches the foot is detached. The tendons must be shortened with scissors, and the malleoli removed; but unless the lower end of the tibia is diseased, there is no need to remove the cartilage. The arteries divided are the dorsalis pedis and the two plantars. It is of consequence not to cut the posterior tibial before its division, as the nutrition of the flap depends mainly upon the calcanean branches.

*Roux's.*—In this the flap is taken from the inner side. The incision forms an irregular oval, commencing at the apex of the external malleolus, running across the front of the ankle as far as the scaphoid on the inner side, then sweeping round to gain the middle line of the sole, passing up the posterior border of the tendo-Achillis, and ending where it began.

*Pirogoff's.*—The posterior portion of the os calcis is sawn off and brought face to face with the cut surface of the tibia. The limb is longer than after a Syme's, and the stump wastes less, but it is not suited to cases in which the bones are diseased.

The position of the foot and the incisions are almost the same as in a Syme's, but the plantar one, instead of sloping backward, passes transversely across the sole from point to point, or, if the arch of the foot is very high, may even slant a little

FIG. 529.—Pirogoff's Amputation. Heel Flap with Os Calcis.

FIG. 530.—Stump after Pirogoff's Amputation.

forward. The amputation may either be performed in the same order as a Syme's, the os calcis being sawn through from above instead of being detached, or the bone may be divided through the plantar incision as soon as this is made, the chief advantage being that it is more easily held. In either case the line of section should run from above downward and forward so as to secure a large surface and prevent tension upon the tendo-Achillis. Pirrie advocates sawing the tibia through in the same way from the dorsal incision without opening the joint, a few tendinous and ligamentous bands only requiring division afterward. Apposition of the bony surfaces is best secured by one or two chromic gut sutures passed through them.

### AMPUTATIONS THROUGH THE FOOT.

The most important are Chopart's, Tripier's, the subastragalar operation, and Hey's or Lisfranc's. Formal operations, however, are seldom performed; in cases of disease in which local measures have failed, it is rarely possible to leave much of

the tarsus; and after injury it is better simply to prevent decomposition and wait until it is seen how far the tissues can repair the damage of themselves. Following this principle, on one occasion, in which the contents of a gun had blown a hole through a man's foot, I succeeded so well that within six months the patient could walk three or four miles and ascend ladders without inconvenience.

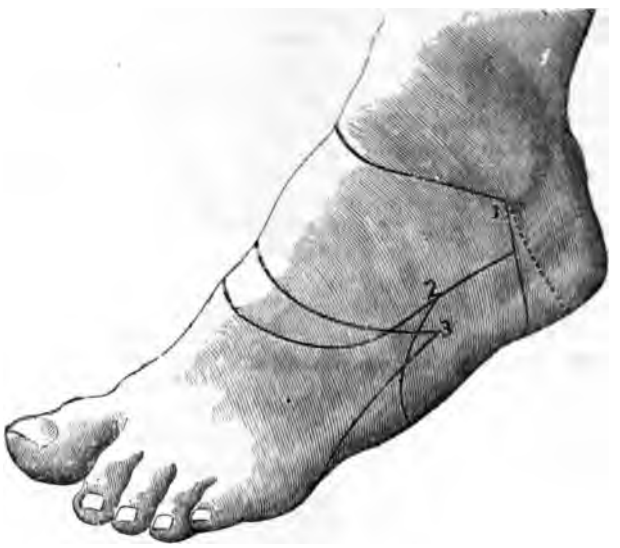



FIG. 531.—1. The Incisions in Pirogoff's Amputation. The dotted line shows the direction of the plantar incision in that of Syme. 2. The incision is subastragaloid; and 3, those in Chopart's amputation.

*Chopart's Amputation through the Mid-tarsal Joint.*—The foot is supported as in Syme's operation, and the anterior part held in the left hand so that it may be placed in extreme plantar or dorsal flexion as required. The tubercle of the scaphoid and the corresponding point on the opposite side (midway between the

FIG. 532.—Stump left after Chopart's Amputation.

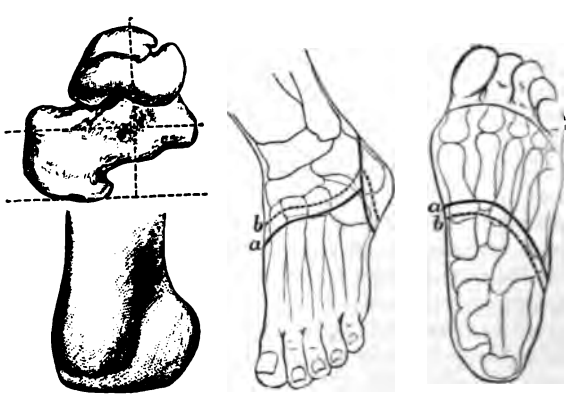



FIG. 533.—Tripier's Amputation of the Foot. (*a*) Section through the skin; (*b*) through the soft parts.

external malleolus and the base of the fifth metatarsal) are defined, and the plantar flap marked out first. It extends from behind the tuberosity of the fifth metatarsal along the outer side of the foot to the ball of the toe, then obliquely forward across the sole (so that it may be longer on the inner side than the outer), and back along the inner border to the scaphoid. The dorsal incision may be made

next, but, as in disarticulating there is some risk of wounding the structures in the sole, it is better to dissect the plantar flap back from off the bones (taking care to include the artery) and have it held well out of the way. The two ends of the plantar incision are then connected over the dorsum by a second, slightly convex forward, the extensor tendons and ligaments divided, and disarticulation completed.

The stump left by this operation is in many cases exceedingly good; but sometimes it tilts so far forward that the cicatrix presses against the ground. It is probable (as the os calcis and astragalus, having lost the support of the anterior pillar of the arch of the foot, must always tilt downward in this way) that this arises from the plantar flap being too short; or it may result from unopposed contraction of the gastrocnemius. It can usually be prevented by dividing the tendo-Achillis and suturing the extensor tendons in front into the periosteum or the cut ends of the ligaments.

*Tripier's.*—The under part of the os calcis is sawn off horizontally just below the sustentaculum tali (having as far as possible preserved the periosteum) in order to leave a surface at right angles to the axis of the tibia.

The incision (through the skin only) begins at the outer edge of the tendo-Achillis, on a level with the external malleolus, and runs downward and forward below that projection to the base of the metatarsal bone of the fifth toe. Thence it passes slightly convex forward, across the sole, until it reaches the inner side of

FIG. 534.—Stump after Hey's Amputation.

the foot, well in front of the projection caused by the base of the first metatarsal; and winding upward over the inner border, continues across the dorsum until it joins the first over the calcaneo-cuboid articulation. As soon as the skin has retracted, the soft parts are divided down to the bones; disarticulation effected at the mid-tarsal joint; the periosteum detached from the under surface of the os calcis, and the bone sawn through, from behind and within, forward and outward.

*The Subastragalar Operation.*—The incision for this is nearly the same, but it commences an inch below the external malleolus (instead of at the tendo-Achillis) and does not run quite so far forward on the sole of the foot. The soft parts must be dissected off the under surface of the cuboid and os calcis; the interosseous ligament between the latter bone and the astragalus divided from in front (space can be obtained by depressing the toes) and then the tissues on the inner side and the tendo-Achillis. The operation is one seldom performed in England, and opinions as to its merits are undecided.

*Hey's and Lisfranc's Amputation of the Toes at the Tarso-metatarsal Articulation.*—In the former the saw was used to a limited extent (in one of the original operations the internal cuneiform was divided); in the latter the disarticulation is complete. The operation is performed in the same way and by the same incision as Chopart's, with the exception that instead of the scaphoid and the calcaneo-cuboid articulation being used as landmarks, the bases of the first and fifth metatarsals

are taken. A plantar flap running across the heads of the metatarsals and longer on the inner side than the outer, is marked out and dissected back ; the posterior ends of the lateral incisions are joined by one across the dorsum, and the toes being depressed as far as possible, the dorsal ligaments of the three outer and the inner metatarsal articulations divided. The articulation of the second, which is placed in a recess posterior to the others, must either be dealt with by itself, using the point of the knife lightly, or the base of the bone sawn off.

### Amputation of the Toes.

The incisions are the same as in the case of the fingers, but on no account may the part of the sole that receives the pressure of the foot be interfered with.

Fig. 535.—Incision for Amputation of the Great Toe.

Fig. 537.—Incision for Removal of the Metatarsal Bone of the Great Toe.

Fig. 536.- Dubreuil's Operation for the Removal of all the Toes.

Fig. 538.—Stump after the Removal of Metatarsal Bone.

The tendon-sheaths should be secured by sutures, as otherwise they form open vertical drains (when the patient is lying in bed), conducting into the sole of the foot any discharge that does not escape at once.

Amputation of the great toe is performed by means of a racquet-shaped incision ; the head of the metatarsal should always be preserved if possible, and when it is necessary to remove this bone (which may be done through a similar incision

commenced further back), the base, with the insertion of the peroneus longus, should be left intact.

## Diseases of Stumps.

The tissues in a stump always waste to some extent; the bones atrophy, the muscular fibres disappear, the vessels contract, and the temperature falls. The skin, however, should retain its natural texture and color, there should be no tender spot, the scar should be well out of the way of pressure, and not adherent to the bone, and there should be a good pad of fatty and fibrous tissue around the end.

*Conical Stump.*—A stump may become conical either from a deficiency in the soft parts, or from growth of the bone. The former usually arises from the flaps having been originally too short, from their having retracted owing to the amount of muscle contained in them, or from their having sloughed. The latter seldom occurs except in children, and in them especially in the leg. The treatment consists either in excising the end of the bone, slitting up one side of the stump to render it more accessible, or re-amputation, according to the condition of the part.

*Necrosis.*—This may arise from the periosteum having been stripped off too far, so that the end of the bone is deprived of its blood supply, or from inflammation. In the latter case the extent depends upon the severity of the attack—there may be merely a scale from the end of the bone, or a long, tubular sequestrum.

*Aneurysm* has been known to develop, and one or two cases of *arterio-venous aneurysm* are on record.

*Neuralgia* (p. 177) may arise from a nerve being involved in the cicatrix, so that it is dragged upon by the scar tissue, or from the end of one becoming bulbous. In the latter case there appears to be a growth of nerve fibres, but the bulk of the mass is made up of connective tissue (pp. 137 and 305). The pain, when one of these is touched, is described as like an electric shock, shooting down the distribution of the nerve. The only treatment is excision, and usually it succeeds at once.

There is, however, another variety of neuralgia very much more serious in character. The stump is red and glazed; to the touch it is icy-cold, but the patient complains of an intense ceaseless burning; no one part is worse than the other; the whole of the limb for some distance is exquisitely tender and the seat of agonizing pain. It is not known to what this is due; nerve section and nerve stretching have only a transient influence on it, and I have known it return again and again in the stump after amputation had been performed in the hope of securing relief.

*Muscular spasm* of a chronic character is sometimes met with. Usually it is due to reflex irritation, but in many cases no cause can be found. Relief, when only a single muscle is affected, can be obtained by tenotomy, but unless the source of irritation is removed the spasms are very likely to recur.

In addition, stumps are liable to be attacked by epithelioma, cheloid, and the other affections of scars; and in cases of amputation for disease, if the line of section is not sufficiently high, recurrence takes place in the stump.

# CHAPTER XXVIII.

## THE PRINCIPLES OF MILITARY SURGERY.

By the Editor, John B. Hamilton, M.D.

It is not contemplated in this chapter to touch upon any of the duties of the military surgeon, except those purely surgical, or which relate directly to the care of the wounded. It is recognized that the most important military duty of the medical officer is the preservation of the health of the troops, by the application of general hygienic rules, modified according to the local environment and the duty on which the command is engaged. There are important military regulations relating to the official conduct of young officers, their duty in the field and the camp, hospital organization, medical and subsistence supplies, and the examination of recruits. However appropriate the consideration of these topics to a special work on military medicine and surgery, it may well be omitted here. The Medical Department of the U. S. Army now issue very complete instructions on these points, and on application through proper channels, it is understood that the medical officers of the U. S. National Guard will be supplied with the following:— "U. S. Army Regulations," "Standard Supply Table," "The Manual of Drill for the Use of the Hospital Corps," "An Epitome of Tripler's Manual and other Publications on the Examination of Recruits," by Deputy Surgeon General Greenleaf; and the "Handbook for the Hospital Corps," by Major Charles Smart, Surgeon, U. S. A. The Bureau of Medicine and Surgery of the U. S. Navy issue the "Regulations of the Medical Department of the Navy," and "First Aid to the Injured and Transportation of the Wounded," by P. A. Surgeon Beyer,* U. S. N.

**First Aid to the Wounded.**—The U. S. A. Hospital Corps consists of hospital stewards and enlisted men. This corps, under the command of medical officers, perform all necessary hospital service in garrison and in the field, and the ambulance service in action. In addition to this force, there are in each company four men who are designated as company litter bearers. These men, as well as the Hospital Corps proper, are instructed four hours each month in the duties of litter bearer and the methods of rendering first aid to the wounded. During an engagement the company litter bearers may be designated to give first aid and carry wounded to the dressing station in the rear, and continue to so act until relieved by the Hospital Corps, when they immediately rejoin their company.

Under existing regulations those wounded during an engagement receive attention in the following order: 1, With the line of battle under fire; 2, at the first dressing station; 3, at the ambulance station; 4, at the division hospitals. "The first dressing station is established at the nearest place to the combatants, where the wounded and those caring for them may not be unnecessarily exposed to fire." Ambulance stations are established "at some place of security in the rear, or in some convenient building near the field of battle." The division hospital may be established in such secure place as the medical director may designate.

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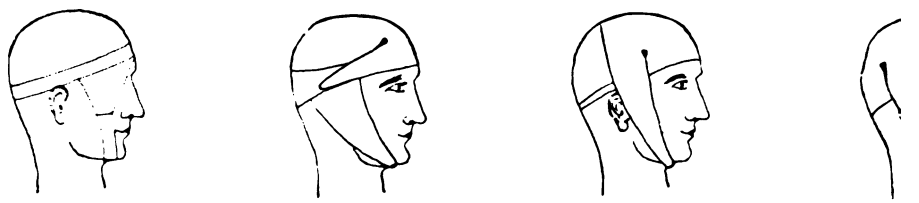
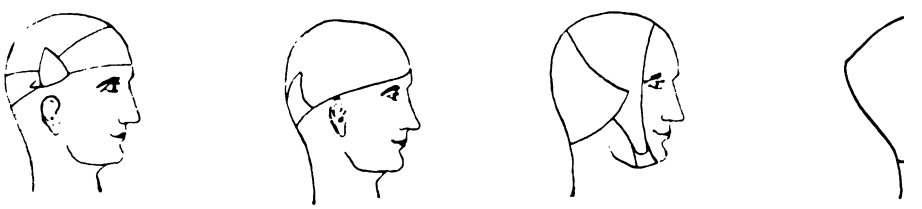
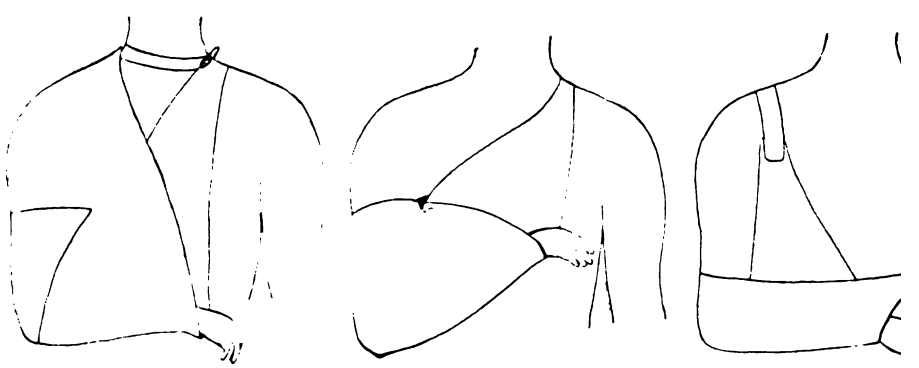
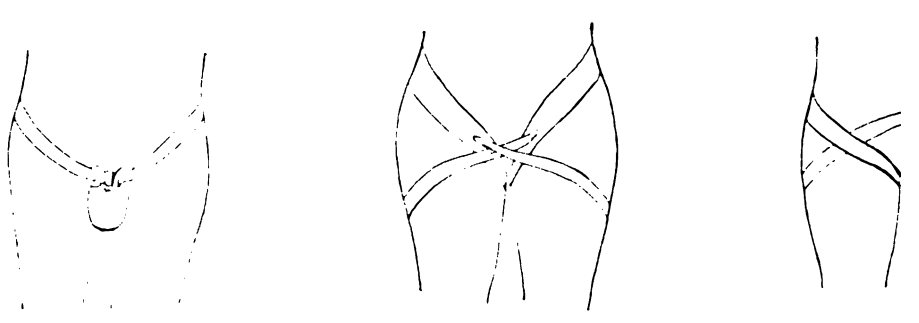
* In addition to the official publications above mentioned, the following will be found useful: "First Aid in Illness and Injury," by Captain James E. Pilcher, Assistant Surgeon U. S. A., New York, 1892; "The Surgeon's Pocketbook," by Surgeon-Major J. H. Porter; revised and edited by Brigade Surgeon C. H. Y. Godwin; and an article in the "International Encyclopædia of Surgery," vol. vi, page 764, by Bvt. Lieutenant Colonel Bennett A. Clements, Surgeon, U. S. A., entitled "Preparation of Military Surgeons for Field Duties; Apparatus Required; Ambulances; Duties in the Field."

# HANDKERCHIEF BANDAGES.









Each soldier should be supplied with a packet which will contain the materials necessary for a first dressing in case of wound. The contents of this package are those recommended by Esmarch, viz.: Two antiseptic compresses of sublimated gauze in oiled paper; one antiseptic bandage of sublimated cambric with safety pin; one Esmarch's triangular bandage with safety-pin; mode of application illustrated on same. The directions accompanying the packet are as follows: "Place one of the compresses on the wound, removing the oiled paper. In cases of large wounds open the compress and cover the whole wound. Apply the anti-

FIG. 539.—Esmarch's Triangular Bandage.

septic bandage over the compress. Then use the triangular bandage as shown by the illustrations on the same." The packet may also contain a tag on which the soldier's name, company, and regiment may be written. The company litter bearers may be so well instructed that in many cases the second dressing at the dressing station may be dispensed with. The accompanying illustration from Pilcher shows the methods of application of the triangular bandage. It will be seen on investigation that the figures show the bandage is really the triangular bandage invented by M. Matthias Mayor in 1838. Surgeon General

FIG. 540.—Lifting the Patient.

Esmarch, however, although giving due credit to M. Mayor, caused them to be introduced into the Prussian Army in 1869, and they have borne his name in Germany.

The bandages having been applied, the wounded man is placed on the litter and carried to the dressing station, where a medical officer examines the patient, and again dresses the wound if necessary.

In case the nature of the wound is such that immediate attention is necessary, a cloth tag is then pinned on to the wounded man, of a certain color, which insures such attention at the hospital, to which the patient is then taken by litter or

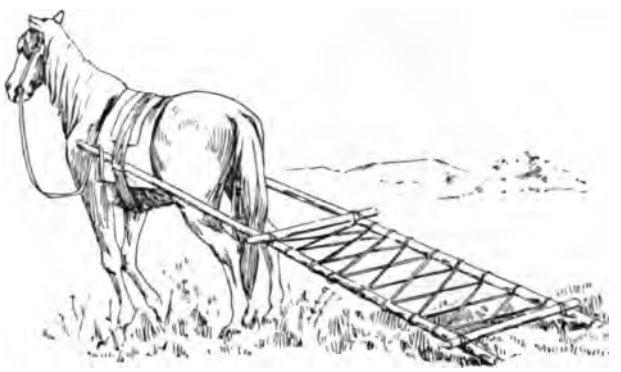
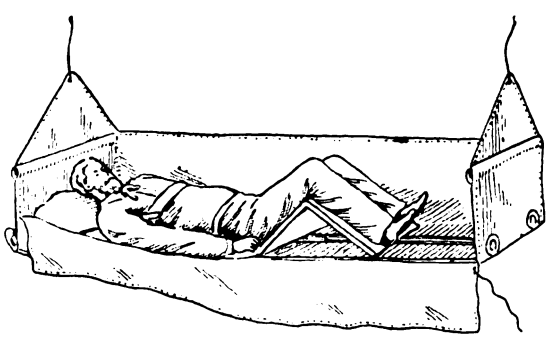


FIG. 545.—The Travois.



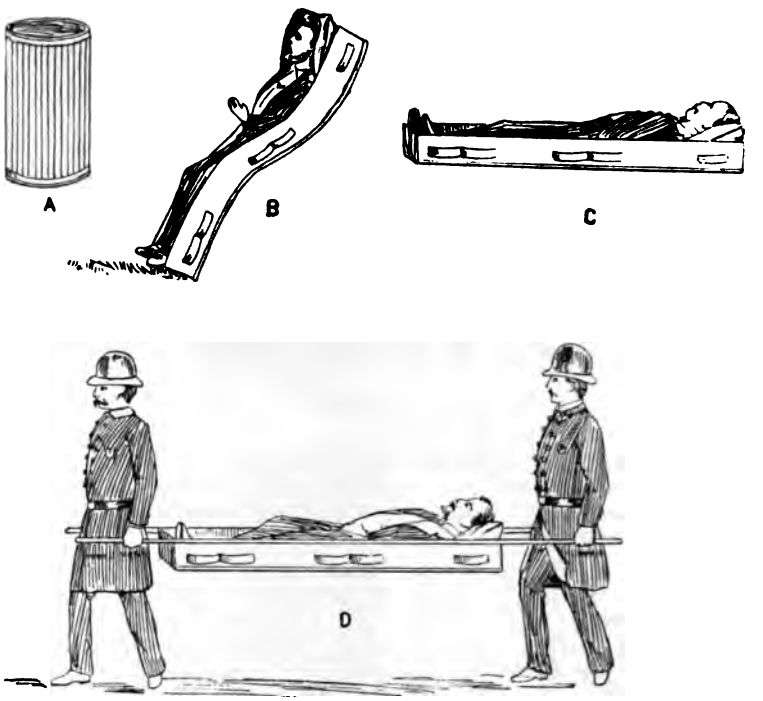



FIG. 548.—Walton-Wells Cot.

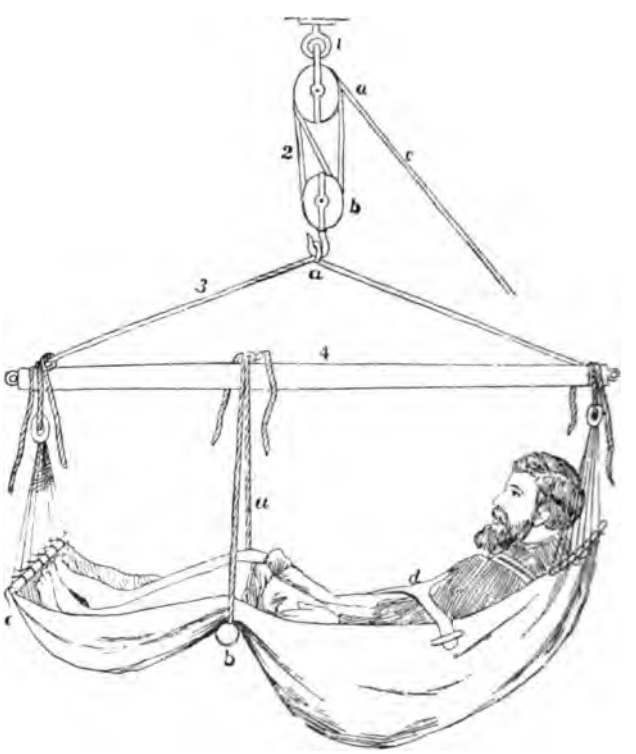



FIG. 549.—The McDonald's Ambulance Lift.

officer, and act under the orders of the medical officer on duty. The wounded are cared for usually by being brought immediately into the sick bay, or hospital, where their wounds are dressed as in a field hospital. No system of litter drill has as yet been adopted by the Navy Department, although it would seem desirable. Various forms of cot or combined stretcher with cot have been devised by naval surgeons for the transportation of the wounded on shipboard, and from one ship to another. The respective cots of Gorgas, Gihon, and Wells are shown in the diagram.

The Walton-Wells cot is made of canvas, and when rolled tightly takes up much less space than any other. The figure represents the Wells cot—*a*, rolled; *b*, at an angle; *c*, cot without poles; *d*, with poles.

McDonald's ambulance lift as shown in the cut (Fig. 549) will be found very useful either in lowering a wounded man over the ship's side or in bringing him on board.

## GUNSHOT WOUNDS.

The literature of this branch of military surgery is almost wholly modern, the use of gunpowder having been rediscovered by Schwartz in 1320. The first important engagement in which cannon was used in Europe was at the battle of Crécy, August, 1346. At first stones were used as projectiles in cannon, but lead and iron soon came into use, and muskets and pistols caused new varieties of wounds. While the general subject was new, the surgeons of the time considered that gunshot wounds were poisoned by the action of the powder, an idea which was not dissipated until the beginning of the fifteenth century.

"Giovanni de Vigo" (b. 1503), says Sprengel, "attributed the danger from gunshot wounds to the round form of the balls, the burning of the parts, to the poisonous qualities of the firearm, and of the powder. After this he established two indications for treatment: first, a humectant (moistener), to cure the burn; second, a desiccator, for the abatement of the poison. He applied a red-hot iron with a view of destroying the poison. He also had recourse to 'Egyptian' ointment or boiling oil, followed by friction with fresh butter to detach the eschar, and he highly praised a 'digestive' composed of yolk of egg and spirits of turpentine to calm the pain."

Alphonse Ferri (*b.* 1515 *d.* 1595), of Naples, also believed that these wounds were poisoned. He was probably the first to speak of the "wind of the bullet," which he asserted caused death almost as often as the bullet itself. He treated these wounds by a caustic composed of corrosive sublimate, sulphate of copper and impure carbonate of lead (litharge). He regarded the extraction of the ball as precedent to cure, and invented a bullet forceps, which after him was called the *Alphonsin*. The accompanying plate from Scultetus shows the instrument as supplied to surgeons in his time. It will be noticed that what would now be termed antiseptic treatment, although rather heroic, figures largely in the means of cure.

Gunshot wounds differ in few essential particulars from other wounds. The velocity of the ball determines its course through the tissues and the relative laceration. The results show that these wounds are distributed over the regions of the body in pretty close ratio to the area of exposed surface. The changes in the shape of projectiles have correspondingly changed the character of the wounds; stronger powder, conical projectiles, and rifled bores have increased the velocity of bullets and lessened the laceration. This remark can only apply to small arms, for the immense weight and size of cannon projectiles produce crushing wounds, like those of railway wrecks. The effect of smokeless powder can now only be conjectured, as no engagement has taken place where it has been used, but it is probable that, with the greater accuracy of aim, the relative proportion of wounded to the whole number engaged will be increased. The effect of velocity has been mentioned. A ball, striking the body at a very high velocity, may pass directly through a bone without splintering, or may perforate the body or the skull. A

ball, having its velocity reduced by distance or obstacles, on striking the body produces greater laceration, and may pursue a quite erratic course, being deflected by bone, tendon, or skin. Instances are frequent where a ball has passed almost around the body, around the skull, or, striking a long bone, has traversed its length. At short range, and with modern weapons, we should expect the bullet to take a nearly straight course. Neglect of this presumption sometimes causes the patient much unnecessary suffering, and the surgeon much annoyance in his search for the ball.

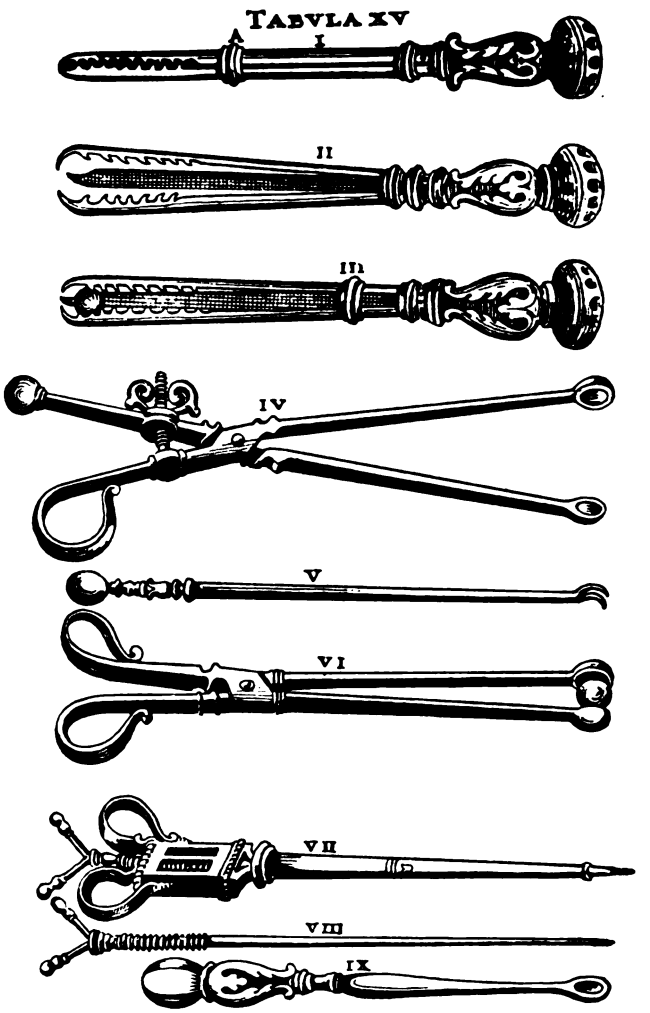



FIG. 550.—Ancient Bullet Extractors. (From Scultetus.)

*Examination of Gunshot Wounds.*—It is useless to expect that the company bearers at the front will have the time, knowledge, or disposition to make a complete examination, and their duties should be considered as satisfactorily performed when they apply the compress or plug the wound, put on the triangular bandage, and carry the wounded to the dressing station. At the dressing station, if the hemorrhage is stopped, and there is little shock, no further examination should be made, nor any attempt to remove the ball, but the patient sent immediately to the

hospital. If there is hemorrhage, both ends of the bleeding vessel should be tied in the wound, and at this time the ball should be extracted when practicable. If there is shock, appropriate remedies should be administered, and heat applied if possible. If there is fracture of the arm or leg, a temporary splint, or compress, should be applied. When the patient arrives at the hospital, systematic examination should be made as soon as practicable after reaction shall have taken place.

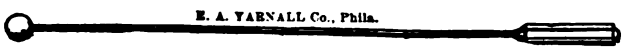



FIG. 551.—The Nélaton Probe.

No anæsthetic should be administered while there is shock, the presence of which is an excellent reason for postponing examination until reaction is complete.

Gunshot wounds are divided into perforating, penetrating, and lacerated wounds and fractures. No ball passes into the tissue with such velocity as to make an incised wound, but some of them come very near it. The clothing should be examined for the purpose of ascertaining whether there is loss of its

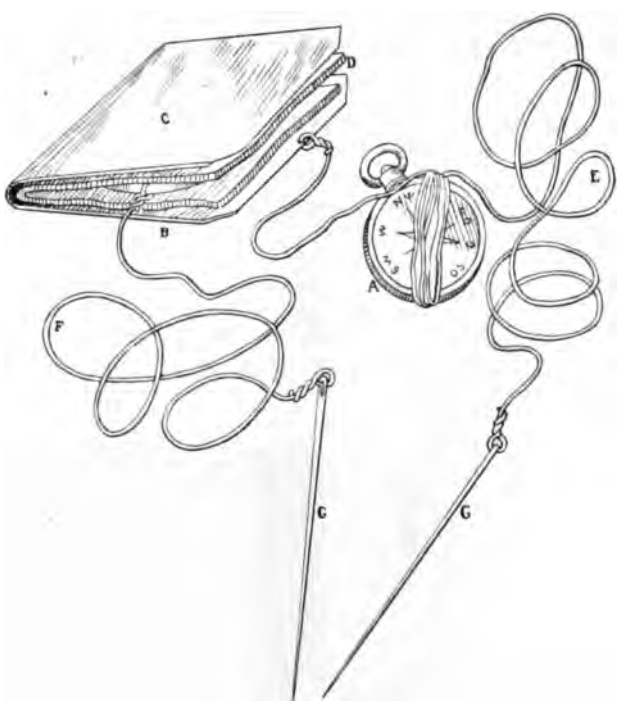



FIG. 552.—Longmore's Electric Explorer. A, Pocket compass; B, Copper sheeting (a penny piece will answer); C, Plate of zinc; D, Flannel saturated with dilute acid; E and F, Insulated wires; G, Exploring needles. (Porter.)

substance, and whether any pieces were carried into the wound. Sometimes the projectile itself is found during the examination of the clothing.

The hands of the surgeon and his assistant having been cleansed and rendered aseptic, the skin about the wound is shaved, scrubbed with soap and water, and then with alcohol or ether. The wound may now be probed by the little finger of the surgeon or the bullet probe. The Nélaton probe is one of the most generally useful. Le[illegible]te's probe (stylet pince) are occasionally

useful. Fluhrer's aluminium probe, on account of its light weight, is less objectionable than many others. It is especially useful in wounds of the brain or lungs. Electricity has been brought into use by the construction of electric probes. Taylor's, DeWilde's, Liebreich's, Bell's, and Sir Thomas Longmore's are those which have recently been used. Longmore's instrument, which can be readily made by any electrician instrument maker, or mechanician, is thus described by Porter: "The magnet of an ordinary pocket compass, which has had some turns of wire covered with thread wound round it as an induction coil, is employed for the electric indicator, while a piece of zinc sheeting bent round a small plate of copper, but separated from it by a flannel padding saturated with the usual dilute acids, forms the voltaic pile. The exploring instrument is formed by two insulated wires bound together but the points left free. These parts being connected, when the circuit is completed by contact with metal, the indication is given by movement of the magnet of the compass."

*Extraction of Balls.*—The number of instruments devised for this purpose is almost infinite, but what is known as the American bullet forceps will be found adapted to the greatest number of cases. For fragments of shells, the ordinary elevator from the trephining set or a lithotomy scoop will be found useful. When the bullet is near the skin it should be fixed by needles or grasped between the thumb and finger while the incision is made over it. In case the ball is lodged in the bone, it must be cut out. After the ball has been extracted the wound should be irrigated thoroughly with some antiseptic solution, sublimate,

FIG. 553.—American Bullet Forceps.

iodine, or bromine, and during the irrigation the surgeon may re-introduce his finger to search for pieces of clothing, buttons, or spiculæ of bone. All foreign substances having been removed, a drainage tube should be inserted to the bottom of the wound (in the brain aseptic horsehairs may be used instead of drainage tubes), and the wound then dresssd by antiseptic compresses, absorbent cotton, and bandage. In case there is no rise in the temperature, or hemorrhage, on the fourth day the wound should be examined, the drainage tube permanently removed, the bullet track irrigated with an antiseptic solution, rebandaged and allowed to close. In cases where the patient arrives at the hospital with the wound septic, the most thorough irrigation should be made twice a day, or oftener if there is need. Almost any wound may be made aseptic if sufficient care is taken that the antiseptic fluids touch every portion of the pyogenic track. In case an abscess cavity has formed, a counter opening should be promptly made, so that perfect drainage may be secured.

**Gunshot Fractures.**—These injuries, after the ball has been extracted, should be treated the same as open fractures. That is to say—the ball is removed, the bleeding arrested, the wound irrigated with sterilized water, or weak sublimate solution until entirely clean, the skin is shaved and properly cleansed, all loose fragments of bone are removed, the limb is placed in position, and, when practicable, the fractured ends are brought together by sewing the periosteum across the line of fracture, or fastened by Senn's bone thimble; drainage is secured, the wound is dressed aseptically, and over all a plaster

bandage is applied. After the plaster hardens a fenestra may be cut opposite the wound. When treated in this way, and treated early, amputation will rarely be required. The special symptoms and treatment necessary in wounds of the various regions have been treated of so thoroughly by our author that separate mention here is not required, and the reader is referred to the chapters on injuries for the discussion of wounds of the particular organs. Wherever a joint is involved it should be immobilized.

Bayonet, lance, and sword wounds are in no respect different from other punctured and lacerated wounds. The requirements are the same, and in their treatment antiseptics and drainage are the essentials.

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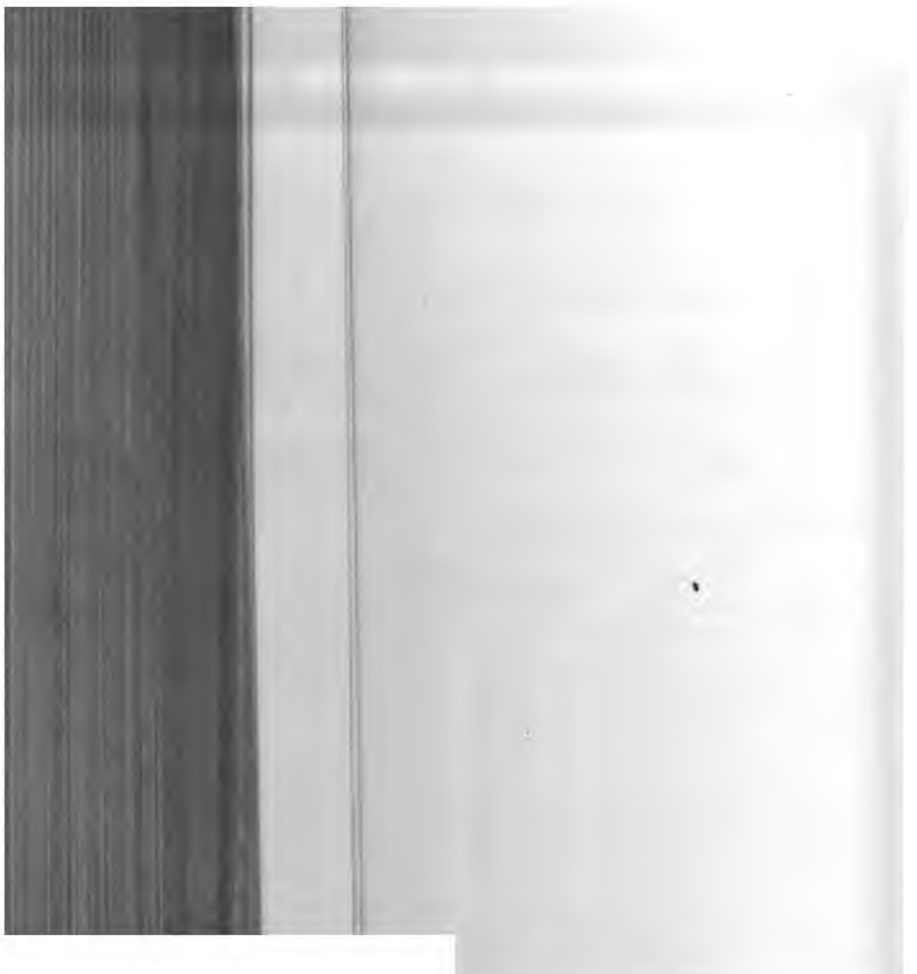
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